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Stomach Contents of Commercially Important Fishes Landed in British Columbia During 1982-83. I. Pacific Cod (*Gadus macrocephalus*), September-November 1982

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STOMACH CONTENTS OF COMMERCIALLY IMPORTANT FISHES LANDED IN BRITISH COLUMBIA DURING 1982-83. I. PACIFIC COD (*Gadus macrocephalus*), SEPTEMBER-NOVEMBER 1982

by

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ABSTRACT

Westrheim, S. J., P. B. McCarter, and D. E. Hay. 1989. Stomach contents of commercially important fishes landed in British Columbia during 1982-83. I. Pacific cod (Gadus macrocephalus), September-November 1982. Can. MS Rep. Fish. Aquat. Sci. 2025: 69 p.

During September-November 1982, 1395 stomachs were collected, in 12 samples, from trawl-caught Pacific cod (Gadus macrocephalus) landed at British Columbia processing plants. Catch locations were Queen Charlotte Sound (Areas 5A+5B), Hecate Strait-Dixon Entrance (Areas 5C+5D), and the west coast of the Queen Charlotte Islands (Area 5E). Sample size ranged from 18 to 201 stomachs. Stomach contents were divided into three components (fish, invertebrate, and miscellaneous), and quantified by number and weight. Fish predominated by weight, but no component dominated by numbers. Fish incidence varied directly with fork length, and invertebrate incidence varied inversely. Principal within-component categories were: Pacific sandlance (Ammodytes hexapterus), Pacific herring (Clupea harengus pallasi), and flounder (Pleuronectidae) among Fish; shrimp (Crangonidae and Pandalidae) and crab (mostly Cancer sp.) among Invertebrates; and unidentified digested matter among Miscellaneous categories. Herring and Pandalidae predominated in Queen Charlotte Sound, while Pacific sandlance and Crangonidae predominated in Hecate Strait and Dixon Entrance. Only 18 stomachs were collected from Area 5E, and the predominant item was Pacific sandlance. Among-sample relationship was homogeneous for the three samples from south Hecate Strait, and heterogeneous for the five samples from north Hecate Strait-Dixon Entrance. Stomach content-weight as a proportion of dressed body weight (viscera and gills removed) ranged from 5.0 to 12.4% among length intervals, in the three areas for which adequate data were available - 5B, 5C, and 5D. Proportion-length relationship was bi-modal in Area 5B, and undulating, dome-shaped in Areas 5C and 5D. Generally similar results were noted in reports of other investigations.

RÉSUME

Westrheim, S. J., P. B. McCarter, and D. E. Hay. 1989. Stomach contents of commercially important fishes landed in British Columbia during 1982-83. I. Pacific cod (Gadus macrocephalus), September-November 1982. Can. MS Rep. Fish. Aquat. Sci. 2025: 69 p.

En septembre et novembre 1982, 1395 estomacs de morue du Pacifique (Gadus macrocephalus) ont été prélevés en 12 échantillons parmi les poissons capturés au chalut et acheminés dans les usines de transformation de la Colombie-Britannique. Les prises provenaient du bassin de la Reine-Charlotte (régions 5A + 5B), de la région du détroit d'Hécate et de l'entrée Dixon (régions 5C + 5D) et de la côte ouest des îles de la Reine-Charlotte (région 5E). Le nombre d'estomacs par échantillon a varié de 18 à 201. Le contenu stomacal a été divisé en trois éléments (poissons, invertébrés et divers) et a été quantifié (nombre et poids). Pour ce qui est du poids, les poissons ont dominé, mais aucun des trois éléments n'a dominé en ce qui a trait au nombre. La fréquence des poissons a varié de manière directement proportionnelle à la longueur à la fourche tandis que pour les invertébrés, la relation a été inversement proportionnelle. Les principales catégories intra-éléments ont été les suivantes: lançon gourdeau (Ammodytes hexapterus), hareng du Pacifique (Clupea harengus pallasi) et plies (Pleuronectidae) dans le cas des poissons, crevettes (Crangonidae et Pandalidae) et crabes (surtout Cancer sp) dans le cas des invertébrés et matières digérées non identifiées dans le cas de la catégorie "divers". Le hareng et les Pandalidae ont prédominé dans le bassin de la Reine-Charlotte, tandis que le lançon gourdeau et les Crangonidae ont prédominé dans le détroit d'Hécate et l'entrée Dixon. Seuls 18 estomacs ont été prélevés dans la région 5E et l'élément prédominant a été le lançon gourdeau. La relation parmi les échantillons a été homogène dans le cas des trois échantillons provenant du sud du détroit d'Hécate et hétérogènes dans le cas des cinq échantillons provenant du nord du détroit d'Hécate et de l'entrée Dixon. Le poids du contenu stomacal, en termes de proportion du poids corporel du poisson apprêté (viscères et branchies enlevées), a varié de 5,0 à 12,4% parmi les intervalles de longueur, dans les trois régions pour lesquelles on dispose de données appropriées, c.-à-d. 5B, 5C et 5D. La relation proportion-longueur a été bimodale dans la région 5B; elle a été ondulée, en forme de dôme dans les régions 5C et 5D. De manière générale, on trouve des résultats semblables dans d'autres rapports de recherche.

INTRODUCTION

In 1982, a study was undertaken to investigate the frequency of Pacific herring[1] in the diets of commercially important fishes, with primary emphasis on groundfish in Hecate Strait (Areas 5C and 5D; Fig. 1). The study was expanded to include other predatory fishes elsewhere, as well as all items in the stomachs of all predators sampled. Duration of the collection phase was September 1982-February 1983. Source of specimens was commercial landings at British Columbia processing plants. Eleven predator species, or species groups, were investigated--arrowtooth flounder; chinook salmon; coho salmon; lingcod; Pacific cod; Pacific hake; Pacific ocean perch; sablefish; skate; and spiny dogfish.

This report deals with the stomach contents of Pacific cod.

MATERIALS AND METHODS

MATERIALS

The only materials in this study were the preserved stomachs (and their contents) collected from trawl-caught Pacific cod landed at processing plants in British Columbia during September-November 1982.

METHODS

The four stages of methodology were collection, field processing, laboratory processing, and analyses.

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[1]Scientific names of all species, and species groups, mentioned in this report are included in Appendix Tables 9 (fish) and 10 (invertebrates).

COLLECTION

All Pacific cod specimens were collected in fillet plants, occasionally after filleting. Specimens were randomly selected without regard to stomach fullness. Minimum sample size was arbitrarily set at 50 fish, and the samples were assumed to represent the commercial size range of cod. The following information was recorded for each stomach collected: serial number; species from which the stomach was removed; location and date of sample; location of catch (major statistical area; minor statistical area; and ground, if available); time spent fishing; preservation method; fishing gear; and fork length (nearest centimeter) of the specimen from which the stomach was removed.

FIELD PROCESSING

Each stomach was placed in a cotton bag, and immersed in a bucket containing 10% formalin. Distended stomachs, heavy with contents, were injected, by hypodermic needle, with 50 cc of 10% formalin prior to immersion.

LABORATORY PROCESSING

At the laboratory, bags of stomachs were initially soaked in cold, running water to dilute the formalin. Following this, wet weights were recorded for each stomach, with and without contents, and for contents alone. Weights were determined with an electronic balance, to the nearest 0.1 g. Stomach contents were then sorted and identified, as far as their condition would permit. Most whole and semi-digested organisms could be classified to genus, and in many instances to species. Related individual genera and species were frequently grouped together into single categories, e.g., flounder, rockfish, euphausiid. For each category (species or species group), numbers of items and and their total wet weight (to the nearest 0.1 g) were recorded. In addition, fork lengths were recorded, to the nearest millimeter, for whole, and partially digested, Pacific herring and Pacific sandlance. All data were coded and stored in the data bank of the computer at the Pacific Biological Station.

Analyses

Stomach contents were initially divided into three major components--fish, invertebrates, and miscellaneous. Each of these in turn was sub-divided into additional categories--18 for fish; 25 for invertebrates; and 7 for miscellaneous.

Content-incidence was reported as percent numbers/stomach, percent g/stomach, and/or g/stomach. The former two were used to delineate variations within and among locations. The latter was used to delineate variations, and trends, among usable, 3-cm length-intervals, within and among locations. Usable length intervals are those containing at least 10 cod (stomachs). Percentages were calculated in the following manner:

$$Pij = (100)(Qij)/(Qtj),$$

where Pij = percent incidence of item i in sample from location j.
Qij = quantity (numbers or weight) of item i in sample from location j.
and Qtj = quantity (numbers or weight) of all items in sample from location j.

Location refers to major statistical area (hereafter referred to as area), minor statistical area (MSA), or trawling ground.

Stomach-content weight/body-weight relationship (%) among usable length intervals, for selected areas, was calculated as follows:

$$Pij = (100)(Wij)/(DWi)$$

where Pij = content-weight/body-weight percentage in length interval i and area j,
Wij = grams/stomach of total major components in length interval i and area j,
DWi = calculated dressed weight (g) in length interval i.

Dressed weight-length formula was taken from Westrheim (1977)--
$DW = 0.008289L^{3.0333}$.

GENERAL RESULTS

During September-November 1982, 1395 stomachs were collected in 12 samples (Table 1). Sample size ranged from 18 to 201 stomachs. Five major statistical areas provided samples--5A (south Queen Charlotte Sound), 5B (north Queen Charlotte Sound), 5C (south Hecate Strait), 5D (north Hecate Strait & Dixon

Entrance), and 5E (west coast of the Queen Charlotte Islands) (Fig. 1). Only 18 stomachs were collected from Area 5E, but elsewhere, area samples ranged from 102 (5A) to 748 (5D). Empty stomachs totalled only 35 (2.5%), and were reasonably distributed among samples. Hence, subsequent computations included all stomachs rather than only "non-empty" stomachs.

Landing records of Pacific cod generally reflect the relative abundance of this species in the sampling areas (Table 2). During September-November 1982, Area 5D produced 67.3% (203.6 t) of the Pacific cod landed from Areas 5A-5E, while Area 5E yielded less than 0.1% (0.1 t). Areas 5A, 5B, and 5C yielded 7.9-13.7% each. A similar relationship among areas existed for January-December 1982, as well as in other years (Foucher and Tyler 1988).

The length-frequency of combined samples of cod was unimodal at 59 cm with a mean length of 59.4 cm and a coefficient of variation (C.V.) of 15% (Table 3). Among areas, all length-frequencies, except that from Area 5D, were at least bi-modal. Mean lengths ranged from 54.0 cm (5E) to 62.1 cm (5D): and C.V.s from 12% (5B) to 18% (5A). Routine length-frequency samples for size and age composition were sparse during the stomach-sampling period. Only three samples were collected, all from Area 5D--two in September and one in November (Table 4). The two September samples were heterogeneous, but their combined distribution was unimodal at 62 cm with a mean length of 62.6 cm and C.V. = 10%. This is comparable to the stomach-sample length-frequency from Area 5D--L = 62.1 cm; C.V. = 14%.

STOMACH CONTENTS

Detailed records, by category and major statistical area, for each major component are included in Appendix Tables--1 (numbers) and 2 (weight) for fish: 3 (numbers) and 4 (weight) for invertebrates: and 5 (weight) for miscellaneous. For Areas 5C and 5D, Appendix Tables 6-8 contain weight data, by category, ground, and/or minor statistical area (MSA), for fish, invertebrates, and miscellaneous, respectively.

TOTAL AND AMONG AREAS

Major Components

Total. Numbers-incidence (%) was relatively uniform among the three major components--30.3% for miscellaneous; 34.8% both for fish and invertebrates (Table 5). Weight-incidence (%) was dominated by fish--54.3% vs 28.1% for miscellaneous, and 17.6% for invertebrates.

Among usable length intervals (41-80 cm), weight incidence for total components ranged from 207 to 572 g/stomach (Fig. 4). Incidence-length relationship exhibited a stepwise, upward trend--207-241 g/stomach at 41-53 cm; 396-479 g/stomach at 56-74 cm. the anomalously low value at 77 cm (252 g/stomach) is not explainable. The relatively high values at 80 cm (572 g/stomach) and 83-89 cm (1713 g/stomach; N = 9) are explained in the following sub-section (Fish). For fish, weight-incidences ranged from 87 to 380 g/stomach. The incidence-length relationship was undulating, with an upward trend. The maximum value occurred at 80 cm. Invertebrate weight-incidence ranged from 30 to 137 g/stomach. Incidence-length relationship was undulating and dome-shaped, except for the maximum value at 80 cm. Peak value occurred at 68 cm (90 g/stomach). Miscellaneous weight-incidences ranged from 36 to 140 g/stomach. Incidence-length relationship was dome-shaped, and the maximum value occurred at 65 cm.

Among areas. Numbers incidences for Areas 5A-5D were relatively uniform for miscellaneous (27.0-37.9%), but less so for fish (22.7-50.1%) and invertebrates (12.1-46.7%) (Table 5). For Area 5E, numbers incidences were 70.3% for fish, 16.2% for miscellaneous, and 13.5% for invertebrates. Weight incidences in Areas 5A-5D were relatively uniform for fish (44.4-59.5%) and miscellaneous (21.4-37.6%), but not for invertebrates (2.9-34.1%). In the latter case, Area 5C yielded the anomalously low value, but excluding that value, the range was still wide--17.6-34.1%.

Among-area comparisons of weight-incidences in usable length intervals were limited to Areas 5B (47-65 cm), 5C (44-68 cm), and 5D (47-80 cm) (Table 3). Samples from Areas 5A and 5E contained inadequate numbers of usable length intervals. Incidence values were expressed as grams/stomach--percentages were not appropriate in this case.

Fish weight-incidences among usable length intervals for Area 5B ranged from 63 to 486 g/stomach (Fig. 5). Incidence-length relationship was stepwise upward, with the maximum value at 65 cm. In Area 5C, incidence values ranged from 104 to 389 g/stomach (44-68 cm). Incidence-length relationship was

undulating, and dome-shaped. Peak value occurred at 62 cm. In Area 5D, values ranged from 17 to 418 g/stomach at 47-80 cm. Excluding the maximum value at 80 cm, the incidence-length relationship was undulating and dome-shaped, with a peak at 71 cm (320 g/stomach).

Invertebrate weight-incidences in Area 5B ranged from 28 to 110 g/stomach (Fig. 6). Incidence-length relationship was undulating, with a downward trend. Peak value occurred at 50 cm. In Area 5C, incidence values were uniformly small (1-29 g/stomach), and exhibited no trend with length. Peak value occurred at 56 cm. In Area 5D, incidence values ranged from 53 to 122 g/stomach. Incidence-length relationship was undulating and dome-shaped. Peak value occurred at 68 cm.

Miscellaneous weight-incidences in Area 5B ranged from 45 to 208 g/stomach (Fig. 7). Incidence-length relationship was similar to that of fish--low values at 47-53 cm, followed by a rapid increase to the peak at 65 cm. In Area 5C, incidence values ranged from 7 to 282 g/stomach. Incidence-length relationship was a stepwise rise to the maximum value at 68 cm. In Area 5D, incidence values ranged from 29 to 90 g/stomach. Incidence-length relationship was broadly dome-shaped, with the peak values at 74 cm.

Fish Categories

Eighteen fish categories were identified (Appendix Tables 1 and 2). Among areas, 16 categories were identified in cod stomachs from Area 5D; 9 each from Areas 5A and 5B; 8 from Area 5C; and 2 from Area 5E.

Total. For combined areas, principal category was Pacific sandlance (hereafter referred to as sandlance), both in numbers-incidence (59.5%) and weight-incidence (39.4%) (Table 6). Secondary important categories were Pacific herring (hereafter referred to as herring) (7.6 and 32.4%), and flounder (7.6 and 12.6%). Other categories in ranks 1-5 were rockfish, eelpout and perch, based on numbers incidence; and rockfish and arrowtooth flounder, based on weight incidence.

Length-frequency samples totalled 58 herring and 1045 sandlance, and were grouped into 1-cm length intervals (1.0-1.9, 2.0-2.9, etc.) (Fig. 8). The small herring sample was difficult to interpret, but appeared to be multi-modal, up to 20.5 cm, with fairly prominent peaks at 4.5, 15.5, and 19.5 cm. Specimens < 2 cm may have been misidentified. The larger sandlance sample displayed two prominent peaks--2.5 and 11.5 cm. Vermeer and Westrheim (1982) reported on the fishes fed to Rhinoceros Auklet (Cerorhinca monocerata) nestlings, by the parents, during July-August 1976-79 in the Queen Charlotte Sound-Hecate Strait

Region. Both herring and sandlance were prominent items in the nestlings' diet. Length-frequency samples of both species were arrayed in 1-cm length intervals. In the herring sample (N=1714), size range was 4.5-17.5 cm and its distribution was somewhat similar to that in the cod-stomach sample--bimodal, with prominent peaks at 8.5 and 11.5 cm (op. cit. Fig. 7). In the sandlance sample (N = 6045), size range was 4.5-19.5 cm, and its distribution was also somewhat similar to that of the cod-stomach sample--bimodal with prominent peaks at 8.5 and 11.5 cm.

Among areas. Eight categories ranked at least fifth in one or more areas, based on numbers or weight incidence (Table 6). Among Areas 5A-5D, sandlance, flounder, herring, and rockfish ranked at least third in one or more areas. By numbers, sandlance ranked first in all four areas (26.5-78.3%). Flounder ranked second in one area (5D, 9.4%), and third in three (5A, 18.1%; 5B, 12.8%; 5C, 3.7%). Herring ranked second in two areas (5A, 25.3%; 5C, 5.8%), and third in one (5D, 7.0%). Rockfish ranked second in one area (5B, 13.0%). By weight, sandlance ranked first in two areas (5C, 66.0%; 5D, 32.8%), and third in one (5A, 8.7%). Flounder ranked second in three areas (5A, 34.4%; 5B, 15.1%; 5D, 13.0%), and third in one (5C, 7.4%). Herring ranked first in two areas (5A, 49.9%; 5B, 60.9%), second in one (5C, 19.3%), and third in one (5D, 12.3%). Rockfish ranked third in one area (5B, 7.6%). In Area 5E, only two categories were reported--sandlance (95.2%) and flounder (1.0%).

Among usable length intervals. For principal fish categories in Areas 5B-5D, weight-incidence/length relationships were heterogeneous among categories and areas (Table 7). Sandlance trends were: undulating upward in 5B; and undulating/dome-shaped in 5C and 5D. Flounder trends were: inverted dome in 5B; dome-shaped in 5C; and undulating upward in 5D. Herring trends were: sharply upward in 5B; undulating upward in 5C; and undulating/dome-shaped in 5D. Rockfish trend was undulating/dome-shaped in 5B. The anomalous appearance of arrowtooth flounder in the previous Area-5D weight-incidence array was due to a relatively substantial quantity recorded from the stomachs of large cod--645 g @ 77 cm; 2920 g @ 80 cm: and 10484 g @ 83-89 cm. None were reported for any cod less than 77 cm FL, although it is possible that the flounder category did contain some smaller specimens.

Invertebrate Categories

A total of 25 individual categories of invertebrates were identified (Appendix Tables 3 and 4). Five phyla were represented--Coelenterata, Echinodermata, Mollusca, Annelida, and Arthropoda.

Total. For combined areas, Arthropoda predominated among phyla, based on numbers (76.8%) and weight (69.5%) incidence (Table 8). Annelida ranked second (11.4 and 23.0%). Within Arthropoda, six categories were identified--shrimp, crab, amphipod, crustacea, euphausiid, and isopod. Shrimp predominated, based on numbers (71.1%) and weight (73.9%) incidences. Crab ranked second in both incidences (19.7 and 15.5%). Within shrimp, five categories were identified--pandalid, crangonid, argid, bladed, and unclassified. Crangonids and pandalids jointly predominated in numbers and weight incidences--43.6 and 24.6% for the former; 27.7 and 48.2% for the latter.

Among areas. Arthropoda predominated among phyla in all areas, both in numbers (73.0-95.5%) and weight (58.6-99.3%) incidence (Table 8). Among Areas 5A-5D, Annelida and Mollusca alternated at ranks 2 and 3, but their incidences were relatively low (1.4-9.9%), except for Areas 5C and/or 5D. There, Annelida numbers-incidence was 14.2% in Area 5D, and weight-incidences were 28.6% in 5C, and 31.1% in 5D. Within Arthropoda, shrimp predominated in all four areas, based on numbers incidence (54.0-89.4%); and by weight in Areas 5A (97.6%), 5B (89.1%), and 5D (62.2%). Shrimp was second (35.9%) to crab (47.4%) in 5C. Crab was second to shrimp in all four areas, based on numbers (8.4-31.7%); and Areas 5A, 5B, and 5D, based on weight (2.1-21.5%). Within shrimp, pandalids predominated, by numbers and weight, in Areas 5A (50.9 and 81.0%) and 5B (58.8 and 64.9%). Crangonids predominated in the same manner in Areas 5C (48.5 and 44.4%) and 5D (54.3 and 43.1%). In Area 5E, Arthropoda predominated by numbers (95.5%) and weight (99.3%). The only other phylum was Mollusca (4.5 and 0.7%). Within Arthropoda, shrimp predominated (84.0 and 97.6%), and within shrimp, pandalids (100%).

Among usable length intervals. Principal invertebrate categories in at least one area of 5A-5D, based on weight-incidence, were Annelida, Mollusca, shrimp, and crab. For these, weight-incidence/length relationships were heterogeneous among categories and areas (Table 9). Combined categories exhibited an undulation trend. Annelida trends were also dome-shaped in 5C and upward in 5D. Mollusca trend was dome-shaped in 5B. Shrimp trends were downward in 5B, and dome-shaped in 5C and 5D. Crab trends were possibly an inverted dome in 5B, and dome-shaped in 5C and 5D.

Miscellaneous Categories

Miscellaneous comprised seven categories--algae (seaweed), stones and sand, unidentified digested matter, unclassified, wood, and parasites (resident) (Appendix Table 5).

By weight, the predominant item was unidentified digestive matter, both overall (88.5%) and among areas (84.3-92.8%) (Table 10). Second in importance was stones and sand--8.7% overall; 4.8-12.7% among areas. Of some interest was the relatively large parasite category resident in the cod stomachs--1.9% overall; 0-2.4% among areas.

Among usable length intervals, in Areas 5B-5D, weight-incidence/length relationships were homogeneous among the three "principal" categories (unidentified digested material, stones and sand, and parasites) (Table 11). Trends were generally undulating upward in all category-area cells, except for parasites in 5D, where the relationship might be dome-shaped. However incidences were small--Trace to 3 g/stomach.

WITHIN AREAS 5C AND 5D

General

Only Areas 5C and 5D provided sufficient samples to justify investigating within-area variations in stomach contents. Eight samples of cod stomachs were involved--3 from 5C, and 5 from 5D (Table 1). Cod landings from Area 5C, during September-November 1982, were virtually all (97.6%) from MSA 2BE, and during January-December, 99.2% (Fig. 1; Table 12). In Area 5D, MSAs 4 (64.7%) and 5U (33.6%) provided most of the landings during September-November 1982, and 66.2% and 31.8%, respectively, during January-December. In both major areas, the spatial pattern of the 1982 landings were similar to those of other years (Foucher and Tyler 1988).

Stomach-sample length-frequencies were all multi-modal (Table 13). In Area 5C, mean lengths were 54.2-58.7 cm, and C.V.s were 12 or 13%. In Area 5D, mean lengths were 55.3-64.2 cm and C.V.s were 12-15%. The single length-frequency stomach-sample from Two Peaks Ground differed from the combined samples collected for size and age composition, with respect to modes (65 cm vs 62 cm), mean length (64.2 ± 1.1; 62.6 ± 0.8), and C.V.s (13%; 14%) (Fig. 8)--another example of the heterogeneity of samples in Area 5D.

Major Components

For Area 5C, the three samples were homogeneous with respect to the three major components (Table 14). Fish generally predominated--numbers-incidence was 43.4-56.5%, and weight-incidence, 56.3-65.4%. Comparable values for invertebrates were 9.9-15.9% and 2.3-3.3%; and for miscellaneous, 33.6%-45.6% and

31.3-41.4%. For Area 5D, heterogeneity was the rule, particularly for fish and invertebrates. Numbers-incidences were 7.3-24.7% for fish, 10.0-78.4% for invertebrates, and 14.2-35.1% for miscellaneous. Corresponding weight-incidences were 15.4-74.4%, 2.8-53.8%, and 20.9-30.8%. Invertebrates predominated in four of the five numbers-incidences, and was second to miscellaneous in the fifth. Fish predominated in three weight-incidences, and invertebrates in two. Even the two samples from MSA 4 were heterogeneous.

Fish Categories

Detailed records of stomach-content weights, by sample and category, are contained in Appendix Table 6. Weight-incidence/length relationships were not compiled for fish, or other major components, due to the few length intervals containing at least 10 stomachs (Table 13).

By weight incidence, 13 categories were ranked fifth or better at least once in the eight samples (Table 15). Principal categories were herring, sandlance, and flounder, which together comprised 82.7-98.1% of the samples from Area 5C, but 18.2-74.3% of the samples from Area 5D. However, two anomalous samples from Area 5D contributed to the heterogeneity. The sample from MSA 1E/MB contained only 22 g/stomach of fish vs 78-424 g/stomach for the other four samples. The category composition is also anomalous. Furthermore, the sample from MSA 4/TP contained an anomalous quantity of Arrowtooth flounder, which was due to a few very large cod containing considerable quantities of this species. Excluding the two anomalous samples from Area 5D, sandlance ranked first in all three samples from Area 5C (46.2-81.7%), and in two (47.2-37.2%) of the remaining three from Area 5D. Rockfish ranked in first (33.9%) in the sample from MSA 2AE/UNK.

Invertebrate Categories

Detailed records of stomach-content weights, by sample, phylum, and category, are contained in Appendix Table 7. Five phyla were represented--Coelenterata, Echinodermata, Mollusca, Annelida, and Arthropoda.

Within phyla, category compositions, and relative weight-incidences were heterogeneous among samples in both Area 5C and Area 5D (Table 16). In Area 5C, Arthropoda, Annelida, and Mollusca were present in all three samples, and in addition, Echinodermata was present in the sample from MSA 5L/UNK. Arthropoda ranked first in samples from 2BE/HS (75.8%) and 6/UNK (75.9%), but second (39.7%) to Annelida (46.0%) in the sample from 5L/UNK. In Area 5D, four phyla (Arthropoda, Annelida,

Mollusca, and Echinodermata) were present in all five samples. Coelenterata was present in three samples (1E/MB, 2AE/UNK, and 4/TP). Arthropoda ranked first in four (56.0-90.2%) of the five samples, and second (34.5%) to Annelida (60.8%) in one (4/UNK). The two samples from MSA 4 were distinctly different.

Within Arthropoda, category compositions, and relative weight incidences, were similarly heterogeneous among samples in both Area 5C and Area 5D (Table 16). In Area 5C, shrimp, crab, and crustacea were present in all three samples. Amphipod was present only in 5L/UNK, while euphausiid was present in 2BE/HS and 5L/UNK. Isopod was absent in all three samples. Shrimp ranked first in the samples from 2BE/HS (34.2%) and 5L/UNK (62.3%), and second (15.2%) to crab (84.7%) in the sample from 6/UNK. In Area 5D, shrimp, crab, amphipod, and crustacea were present in all five samples. Euphausiids were present in three samples (2AE/UNK, 4/UNK, and 4/TP). Isopods were present in two samples (1E/MB and 4/TP). Among shrimp, category compositions, and relative weight incidences, were similarly heterogeneous among samples in both Area 5C and Area 5D.

Miscellaneous Categories

Detailed records of miscellaneous weights, by sample and category, are contained in Appendix Table 8.

For the three samples from Area 5C, category-composition was homogeneous (Table 17). Unidentified digested material was the dominant item--weight-incidence = 82.1-89.6%. Stones and sand ranked second, and comprised 8.6-15.7%. Parasites comprised 1.8-2.5%. Among the five samples from Area 5D, category-composition was also homogeneous, with the possible exception of the sample from MSA 1E/UNK. Unidentified digested matter was the dominant category--weight-incidence was 89.0-95.5% in four of the samples, and 86.2% in the sample from MSA 1E/UNK. Stones and sand ranked second--2.3-4.1% in four samples; 10.8% in the sample from MSA 1E/UNK. Resident parasites comprised 1.2-2.3% in four samples, and 3.1% in the sample from MSA 1E/UNK.

CONTENT WEIGHT VS BODY WEIGHT

Samples from Areas 5B, 5C, and 5D were deemed to have adequate numbers of usable length intervals ($N > 9$) to warrant investigation of the relationship between stomach-content weight and dressed body-weight (gills and viscera removed) within length

intervals (Table 3). Usable size ranges among areas were 47-65 cm (5B), 44-68 cm (5C), and 47-80 cm (5D).

Among usable length intervals, content-weight/body-weight proportions were 5.0-9.7% for Area 5B, 5.0-12.4% for Area 5C, and 1.9-6.0% for Area 5D (Table 18). Among length intervals, relationships were diverse among the three areas--bimodal in 5B (7.1% at 50 cm; 9.7% at 65 cm); undulating, downward in 5C (maximum at 47 cm); and undulating/dome-shaped in 5D (maximum at 59 cm) (Fig. 10).

RESULTS OF PREVIOUS INVESTIGATIONS

Five previous investigations dealt, in some detail, with the diet of Pacific cod in British Columbia waters.

Westrheim (1977) reported on the stomach contents of Pacific cod, in stratified samples, collected and analysed at sea in Areas 3C-N and 5C+5D during April, July, and October 1975, and February 1976. During October 1975, 377 stomachs were examined, of which 322 (85%) contained food (op. cit. Table 17). Fish comprised 27.4% by volume, invertebrates comprised 72.8%. Principal fish categories were herring (5.5%), flatfish (4.6%), and sandlance (2%). "Other fish" comprised 10.3%, of which 75% were unidentified. Principal invertebrates were crangonids (29.7%), euphausiids (19.9%), and pandalids (4.6%). "Other invertebrates" comprised 10.3%, of which 79% was unidentified. Category-composition of stomachs varied with fork length of the cod. For specimens less than 50 cm FL, fish rarely comprised more than 50%, while for specimens 56 cm and larger, fish rarely comprised less than 50%. Weight of stomach contents (exclusive of rocks) averaged 1.4% of dressed weight. Seasonal variations were noted in proportions of empty stomachs, major components, and categories within components. Proportions of empty stomachs was 41% in February, and 3-15% in April, July, and October. Proportion of fish was 27.4% in October, compared to 43.0-60.5% for April, July, and February. Comparable values for invertebrate were 72.8% vs 22.9-57.4%. Principal fish species were sandlance in April and July: "Other" (75% unidentified) in October, and herring in February.

Westrheim et al. (1980a) reported on stomach contents of Pacific cod collected during a June-July 1979 trawl/echo-sounder survey of cod distribution and abundance in Hecate Strait (5C+5D). They examined 559 stomachs of cod, 20-71 cm FL. Principal components were sandlance (185 stomachs) and "shrimp-euphausiids" (254 stomachs). By volume, "shrimp-euphausiids"

predominated in stomachs of smaller cod (43-94% at 20-29 cm), but were absent from larger cod (62-71 cm) (op. cit. Table 4). Corresponding values for sandlance were 0-30% and 83%, respectively. Interestingly, the percentage incidences of both sandlance and shrimp-euphausiids exhibited undulating, but non-synchronous, patterns among length intervals.

Westrheim et al. (1980b) reported on stomach contents of Pacific cod collected during a September 1979 trawl/echo-sounder survey of cod distribution and abundance in Hecate Strait (5C+5D). Stomach contents were intermittently noted while sampling catches for length and sex. In addition, 102 stomachs were collected from one trawl haul (#33) for detailed examination. Intermittent observations were recorded for the catches of six trawl hauls. Fish categories reported were flatfish (3 of 6 hauls), herring (3/6), sandlance (2/6), and walleye pollock (1/6). Principal invertebrate was "shrimp" (4/6). From haul #33, the 102 cod ranged in length from 19 to 84 cm--34-84 cm with fish: 31-63 cm with invertebrates. Principal fish were flatfish, herring and sandlance. Principal invertebrates were amphipods, crabs, euphausiids, and shrimp.

Westrheim and Harling (1983) summarized the qualitative notes on stomach contents of Pacific cod, rock sole, and petrale sole, recorded by Port Liaison Officers as they sampled these species in the processing plants for length, sex, etc. The records encompassed January-December 1950-80, and three major trawling regions--West Vancouver Island (3C+3D), Queen Charlotte Sound (5A+5B), and Hecate Strait (5C+5D). Data were assembled by quarter-year (Jan-Mar, etc.).

In Queen Charlotte Sound, 66 samples of Pacific cod were evaluated. Principal stomach contents were sandlance (83% of samples), herring (39%), and "shrimp" (15%) (op. cit. Table 2). Principal sampling periods were Quarters II (36 samples) and III (27 samples). In both quarters, sandlance predominated over herring--83% vs 39%; and 93% vs 33%. Only one samples was collected in Quarter I, and herring comprised 100%. In Quarter IV, two samples were evaluated, and herring again comprised 100%. Trawl effort is light during Quarters I and IV due to adverse weather.

In Hecate Strait, 304 samples of Pacific cod were evaluated for stomach contents. Principal prey categories were sandlance (52% of samples), herring (39%), sablefish (16%), and "shrimp" (euphausiids, pandalids, etc.) (11%) (op. cit. Table 2). However, incidence of prey categories varied temporally and spatially. In Area 5C, sandlance and herring dominated the stomach contents, but in reciprocal fashion seasonally (op. cit. Table 4). Sandlance predominated in Quarters I (36%), II (95%) and III (100%). Herring was dominant in Quarter IV (100%). In Area 5D, other than White Rocks Ground (MSA 5U, the spawning

area), sandlance predominated in all quarter-years--39-73% vs 21-39% for herring. For White Rocks Ground, samples reflected the seasonal appearance of Pacific cod on this ground. There were 56 samples evaluated in Quarter I (spawning season), and 29 in Quarter IV (pre-spawning aggregations), but only 4 samples in Quarter II and 3 in Quarter III, when most cod had emigrated to shallow-water feeding grounds elsewhere in Hecate Strait. Herring predominated in Quarters I (84%), III (67%), and IV (90%). Sandlance predominated in Quarter II (50%). The dominance of herring is readily explained. Herring were concentrated in pre-spawning schools on White Rocks Ground, as were the Pacific cod, at depths deeper than those normally occupied by sandlance. Of considerable interest was the evidence presented for among-year variable incidence of sandlance in cod stomachs.

Black (1984) reported on the stomach contents of 615 Pacific cod (2-59 cm SL) collected during 1978-81 in a kelp-ecology survey in Queen Charlotte Strait (adjacent to Queen Charlotte Sound), off the northeast coast of Vancouver Island (Area 4B, MSA 12). Fishing gear used were beach seines, gillnets, and purse seines. Principal collecting sites were in and around commercial kelp beds--Macrocystis integrifolia and Nereocystis luetkeana. Fish categories comprised 11 families, and 12 species, as well as clupeid eggs and eggs and larvae of unidentified fish (op. cit. section 1.1). Among the identified fish species were Pacific cod, Pacific herring, yellowtail rockfish, and shiner perch, but no sandlance. MSA 12 is a minor production area for trawl-caught groundfish, perhaps largely due to the lack of trawlable grounds (Westrheim 1980). Invertebrate categories comprised seven phyla--Protozoa, Platyhelminthes, Coelenterata, Echinodermata, Mollusca, Annelida, and Arthropoda. Among the identified species were crabs, cucumbers, and shrimp. Miscellaneous categories comprised algae, stones, and wood.

SUMMARY AND CONCLUSIONS

During September-November 1982, 1395 stomachs were collected, in 12 samples, from trawl-caught Pacific cod landed at British Columbia processing plants. Locations of catch were Queen Charlotte Sound (Areas 5A+5B), Hecate Strait-Dixon Entrance (Areas 5C+5D), and the west coast of the Queen Charlotte Islands (Area 5E). Individual samples ranged from 18 to 201 stomachs. Among areas, sample sizes were 102-748 for Areas 5A-5D, and 18 for Area 5E.

Stomach contents were initially divided into three major components--fish, invertebrates, and miscellaneous. Each of these in turn was sub-divided into categories--18 for fish, 25 for invertebrates, and 7 for miscellaneous. Content-incidences were calculated as numbers and/or weight. Numbers incidence was expressed as percent numbers/100 stomachs. Weight incidence was expressed as percent grams/stomach or grams/stomach. Grams/stomach was used for delineating weight-incidence/length and content-weight/body-weight relationships among usable length intervals (N>9 stomachs/interval).

Empty stomachs comprised 2.5% (35) of the total examined.

Among major components, areas combined, numbers incidence was relatively uniform. Weight incidence was dominated by fish. Among-area comparisons were limited to the Queen Charlotte Sound-Hecate Strait-Dixon Entrance Region, due to the few stomachs collected from off the west coast of the Queen Charlotte Islands. Numbers-incidence was relatively uniform among the three areas for the miscellaneous component, but not for the fish and invertebrate components. Fish predominated in north Queen Charlotte Sound and south Hecate Strait, while invertebrates predominated in south Queen Charlotte Sound and north Hecate Strait-Dixon Entrance. Weight incidence was relatively uniform for fish and miscellaneous, but less so for invertebrates. Fish predominated in all four areas.

For combined components and areas, weight-incidence/length relationship was stepwise upward. Among the three major components, areas combined, relationships were heterogeneous; undulating upward for fish; undulating without trend for invertebrates; and dome-shaped for miscellaneous. Among-area comparisons of major components were limited to the north Queen Charlotte Sound-Hecate Strait-Dixon Entrance Region due to the few length intervals containing at least 10 stomachs in samples from south Queen Charlotte Sound and the west coast of the Queen Charlotte Islands. Among-area relationships for individual major components were also heterogeneous. For fish, the incidence/length relationship was stepwise upward in north Queen Charlotte Sound, and undulating/dome-shaped in Hecate Strait-Dixon Entrance. For Invertebrates, the corresponding relationships were undulating downward (north Queen Charlotte Sound), no trend (south Hecate Strait), and undulating/dome-shaped (north Hecate Strait-Dixon Entrance). Miscellaneous relationships were stepwise/upward (north Queen Charlotte Sound and south Hecate Strait), and dome-shaped (north Hecate Strait-Dixon Strait).

Principal fish categories, for combined areas, by numbers and weight, were sandlance, herring, and flounder. By numbers, sandlance ranked first in all areas. By weight, herring

ranked first in Queen Charlotte Sound, while sandlance ranked first in Hecate Strait-Dixon Entrance. Weight-incidence/length relationships, areas combined, were undulating and generally dome-shaped for all three important categories.

Principal invertebrate phyla, for combined areas, by numbers and weight, were Arthropoda and Annelida (a poor second). Within Arthropoda, shrimp ranked first, and crab a poor second. Within shrimp, crangonids and pandalids predominated. Among-areas, excluding west Queen Charlotte Islands, Arthropoda predominated in all areas; shrimp predominated by numbers in all areas, and by weight in all areas except south Hecate Strait. Among shrimp, pandalids predominated in Queen Charlotte Sound, and crangonids predominated in Hecate Strait-Dixon Entrance. Weight-incidence/length relationships, areas combined, were undulating/dome-shaped for arthropoda and shrimp, and undulating upward for Annelida and crab.

Principal miscellaneous category, was unidentified digested material among areas in the Queen Charlotte Sound-Hecate Strait-Dixon Entrance Region. Stones and sand ranked a poor second, overall and among areas. Weight-incidence/length relationship, for combined areas, was undulating/dome-shaped for unidentified digested material and stones and sand.

Within-area comparisons were limited to south Hecate Strait (3 samples) and north Hecate Strait-Dixon Entrance (5 samples), due to the few samples collected elsewhere--one each from south Queen Charlotte Sound and west Queen Charlotte Islands, and two from north Queen Charlotte Sound. Among major components, the three samples from south Hecate Strait were generally homogeneous. Fish predominated by numbers in two of the three samples, and by weight in all three samples. For north Hecate Strait-Dixon Entrance, heterogeneity was the rule. Invertebrates predominated by numbers in four of the five samples, and were second to miscellaneous in the fifth. Fish predominated by weight in three samples, and invertebrates in two. Even the two samples from MSA 4 were heterogeneous.

Stomach-content weight as a percentage of body dressed weight (gills and viscera removed) was determined for usable length intervals (N>9 stomachs/interval). Adequate samples were available from north Queen Charlotte Sound and Hecate Strait-Dixon Entrance. Values ranged from 5.0 to 12.4% among length intervals. Percent-length relationships were bimodal in north Queen Charlotte Sound, and undulating/dome-shaped in Hecate Strait-Dixon Entrance.

The principal contributions from this study, and reports of other studies, are among-sample heterogeneity and the weight-incidence/length relationships. Heterogeneity of stomach contents among years, areas and among samples within at least one

area, clearly indicate the need for an extensive and intensive sampling program if either qualitative or quantitative measures of prey consumption by cod "stocks" are to be determined. Sampling over several consecutive years and in all seasons is necessary, together with sampling from individual grounds (or at least MSAs) in proportion to their cod production. For cod less than marketable size, sampling at sea is essential.

Weight-incidence/length relationships were frequently undulating, with trends upward (usually fish), downward (usually invertebrates), or dome-shaped (fish or invertebrates). The contrasting trends of fish and invertebrates was expected, based on other studies, but the undulating, and dome-shaped, trends are not explainable.

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Table 1. Inventory of stomach samples collected from Pacific cod landed in British Columbia, by location of catch and month of landing, September-November 1982.

Area	Location MSA[a]	Ground[b]	Month	Nos. of stomachs Total	Empty
5A	11	Cape Scott Spit	Nov	102	2
5B	8	S.W. Goose Is. Bank	Sep	51	1
		Unknown	Oct	150	1
5C	2BE	Horseshoe	Oct	125	6
	5L	Unknown	Oct	100	1
	6	Unknown	Sep	101	1
5D	1E	McIntyre Bay	Oct	100	1
		Unknown	Oct	99	3
	2AE	Unknown	Sep-Oct	174	7
	4	Two Peaks	Sep	201	3
		Unknown	Sep	174	8
5E	2AW	Unknown	Sep	18	1
Total				1395	35

[a]Minor statistical area.

[b]See Figs. 2 and 3.

Table 2. Trawl landings (t), by month and area, of Pacific cod from Areas 5A-5E, September-November 1982. (Source: Leaman 1983)

Area	Month Sep	Oct	Nov	Total	%	Jan-Dec	% Sep-Nov
5A	22.4	7.9	3.3	33.6	11.1	257.7	13.0
5B	5.0	10.1	8.7	23.8	7.9	336.5	7.1
5C	24.7	7.9	8.7	41.3	13.7	505.1	8.2
5D	104.7	12.2	86.7	203.6	67.3	1559.6	13.1
5E	0.1	--	--	0.1	T	1.3	7.7
Total	156.9	38.1	107.4	302.4	100.0	2660.2	11.4

Table 3. Length-frequencies (nos.), by 3-cm length-interval and area, of Pacific cod sampled for stomach contents in commercial landings from Areas 5A-5E, September-November 1982.

Fork length (cm)	Area 5A	5B	5C	5D	5E	Total	Nos. Empty
32	--	--	1	--	--	1	--
35	1	--	0	1	--	2	1
38	1	--	0	0	--	1	0
41	4	--	4	3	--	11	0
44	14	4	24	4	2	48	1
47	13	20	23	29	4	90	1
50	8	40	37	47	1	132	3
53	10	21	38	71	3	143	4
56	9	27	42	86	3	167	3
59	5	23	57	97	2	184	1
62	12	29	36	88	0	165	4
65	13	24	38	82	1	158	5
68	4	6	17	77	2	108	1
71	4	4	4	63	--	73	6
74	2	2	5	49	--	58	2
77	2	0	--	29	--	31	1
80	--	1	--	10	--	13	2
83	--	--	--	6	--	4	--
86	--	--	--	1	--	1	--
89	--	--	--	2	--	2	--
Sub-total	102	201	326	745	18	1392	35(2.5%)
Unknown	--	--	--	3	--	3	
Total	102	201	326	748	18	1395	35(2.5%)
$\bar{L}$	55.3	56.6	56.5	62.1	54.0	59.4	61.9
C.V. (%)	18	12	13	14	14	15	17

Table 4. Length-frequencies (nos.), by 3-cm length-interval, date, and area, of Pacific cod sampled for size and age composition in commercial landings from Areas 5A-5E, September-November 1982.

Fork length (cm)	September 16	September 20	Total	November 10
Ground:[a]	TP	TP		WR
41	--	--	--	1
44	4	3	7	4
47	2	3	5	7
50	12	8	20	18
53	25	15	40	31
56	24	17	41	47
59	31	25	56	40
62	40	18	58	36
65	25	29	54	27
68	25	22	47	15
71	15	31	46	2
74	4	12	16	--
77	2	12	14	--
80	1	7	8	--
83	--	1	1	--
86	--	1	1	--
Total	210	204	414	228
$\bar{L}$	60.8	64.3	62.6	58.0
C.V.(%)	11	13	13	10

[a]TP=Two Peaks; WR=White Rocks.

Table 5. Numbers and weight incidence (%), by area, for Major Components in stomachs of Pacific cod landed from Areas 5A-5E, September-November 1982.

Area	Nos. of stomachs	Incid[a]	Major components				
			Fish	Invert[b]	Misc	Total	N[c]
5A	102	N	22.7	44.3	33.1	100.1	366
		W	44.4	34.1	21.4	99.9	387
5B	201	N	38.8	34.2	27.0	100.0	614
		W	50.6	17.6	31.7	99.9	397
5C	326	N	50.1	12.1	37.9	100.1	589
		W	59.5	2.9	37.6	100.0	442
5D	748	N	25.7	46.7	27.7	100.1	499
		W	53.4	23.8	22.9	100.1	328
5E	18	N	70.3	13.5	16.2	100.0	827
		W	18.5	1.9	79.6	100.0	54
Total	1395	N	34.8	34.8	30.3	99.9	531
		W	54.3	17.6	28.1	100.0	370

[a]Incidence: N=numbers; W=weight.

[b]Invert = Invertebrates; Misc = Miscellaneous.

[c]N=numbers/100 stomachs (N); and grams/stomach (W).

Table 6. Numbers and weight incidence (%), by area, of important Fish categories in stomachs of Pacific cod landed from Areas 5A-5E, September-October 1982. (Source: Appendix Tables 1 and 2)

Category	No. of occurr.[a]	Area 5A	5B	5C	5D	5E	Total
				Numbers			
Pacific sand lance	5	26.5	32.4	78.3	53.1	95.2	59.5
Flounder	5	18.1	12.6	3.7	9.4	1.0	7.6
Pacific herring	4	25.3	11.8	5.8	7.0	--	7.6
Rockfish	3	4.8	13.0	--	3.9	--	6.2
Eelpout	1	--	6.7	--	--	--	1.6
Perch[b]	1	--	--	1.4	3.1	--	1.6
Poacher	1	4.8	--	--	--	--	1.1
Sculpin	1	--	--	0.7	--	--	0.5
Total		74.7	76.5	89.2	76.5	96.2	84.1
				Weight			
Pacific sand lance	5	8.7	7.0	66.0	32.8	98.0	39.4
Flounder	5	34.4	15.1	7.4	13.0	T	12.6
Pacific herring	4	49.9	60.9	19.3	12.3	--	23.4
Rockfish	3	2.2	7.6	--	10.8	--	6.2
Perch[b]	2	1.2	--	2.3	--	--	4.0
Arrowtooth flounder	1	--	--	--	10.8	--	5.0
Poacher	1	--	1.8	--	--	--	0.5
Sculpin	1	--	--	1.2	--	--	0.5
Total		96.4	92.4	96.2	79.7	98.0	90.6

[a]Number of occurrences in ranks 1-5.

[b]Westrheim & Harling (1983, Appendix Table 1) reported "shiners (Cymatogaster)" (=shiner perch) in cod stomachs from Areas 5C+5D during 1950-80.

Table 7. Weight incidence (g/stomach), by 3-cm length-interval, of important Fish categories[a] in the stomachs of Pacific cod landed from Areas 5B, 5C, and 5D, September-October 1982. (Values in parentheses unusable, N<10. See Table 3).

Fork length (cm)	Area 5B				Area 5C			Area 5D		
	Herr	Floun	Rockf	Sandl	Sandl	Herr	Floun	Sandl	Floun	Herr
32-38	--	--	--	--	(0)	(0)	(0)	(0)	(0)	(0)
41	--	--	--	--	(1)	(89)	(4)	(0)	(0)	(0)
44	(0)	(0)	(18)	(129)	85	15	0	(0)	(0)	(0)
47	0	32	8	14	208	3	2	7	0	4
50	23	28	4	6	171	7	T	6	9	22
53	0	22	18	3	142	47	10	17	10	1
56	74	26	43	8	278	82	21	61	15	14
59	86	31	5	27	102	68	44	115	12	41
62	256	33	20	6	218	70	29	85	12	20
65	385	59	17	17	179	20	15	87	47	18
68	(111)	(0)	(0)	12	195	90	0	48	24	39
71	(588)	(0)	(0)	53	(43)	(3)	(189)	25	45	30
74	(25)	(65)	(0)	(0)	(516)	(314)	(42)	53	67	27
77	--	--	--	--	--	--	--	55	14	4
80	(0)	(0)	(0)	(0)	--	--	--	52	0	1
83-89	--	--	--	--	--	--	--	(0)	(0)	(7)
Unknown	--	--	--	--	--	--	--	(0)	(0)	(0)
Total	123	30	15	14	174	51	20	57	23	21

[a]Floun = Flounder; Herr = Pacific herring; Rockf = Rockfish; Sandl = Pacific sandlance.

Table 8. Numbers (N) and weight (W) incidence (%), by area and category, for Invertebrate categories in stomachs of Pacific cod landed in British Columbia, September-November 1982.

Category	Area 5A		5B		5C		5D		5E		Total	
	N	W	N	W	N	W	N	W	N	W	N	W
Phylum												
Arthropoda	84.6	94.7	85.2	91.7	90.0	61.9	73.0	58.6	95.5	99.3	75.8	69.5
Annelida	5.6	3.1	4.3	1.4	4.3	28.6	14.2	31.1	--	--	11.4	23.0
Mollusca	9.9	1.7	8.6	6.7	5.7	7.9	3.4	2.6	4.5	0.7	4.9	3.4
Echinodermata	--	--	--	--	T	1.6	1.3	1.4	--	--	1.1	0.9
Coelenterata	--	--	--	--	--	--	0.9	0.4	--	--	0.5	0.3
Unidentified	--	--	1.9	0.1	T	T	7.3	5.9	--	--	5.4	3.8
Total (N)[a]	100.1 (162)	100.0 (132)	100.0 (210)	99.9 (70)	100.0 (70)	100.0 (13)	100.1 (78)	100.0 (233)	100.0 (111)	100.0 (55)	100.1 (185)	99.9 (65)
Arthropoda												
Shrimp	83.2	97.6	89.4	89.1	54.0	35.9	68.2	62.2	84.0	97.6	71.1	73.9
Crab	8.8	2.1	8.4	6.7	31.7	47.4	22.4	21.5	5.6	0.9	19.7	15.5
Amphipod	6.6	0.2	0.5	0.2	3.2	T	2.4	0.7	10.4	1.5	2.8	0.4
Crustacea	1.4	0.1	1.7	4.1	7.9	2.6	5.3	12.5	--	--	4.9	7.7
Euphausiid	--	--	--	--	3.2	14.1	1.8	2.9	--	--	1.4	2.2
Isopod	--	--	--	--	--	--	T	0.2	--	--	T	0.2
Total (N)[a]	100.0 (137)	100.0 (125)	100.0 (179)	100.1 (64)	100.0 (63)	100.0 (8)	100.1 (170)	100.0 (46)	100.0 (106)	100.0 (55)	99.9 (142)	99.9 (45)

Table 8 (cont'd)

Category	Area 5A N	5A W	5B N	5B W	5C N	5C W	5D N	5D W	5E N	5E W	Total N	Total W
Shrimp												
Pandalid	50.9	81.0	58.8	64.9	T	T	17.2	23.7	100.0	100.0	27.7	48.2
Crangonid	25.4	7.3	20.6	8.4	48.5	44.4	54.3	43.1	--	--	43.6	24.6
Argid	0.9	T	T	T	3.0	3.7	1.7	2.5	--	--	1.0	0.6
Bladed	0.9	0.2	--	--	T	T	T	T	--	--	T	T
Unidentified	21.9	11.5	20.6	26.7	48.5	51.9	26.7	30.7	--	--	27.7	26.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.0	100.0	100.0
(Incid.)[a]	(114)	(121)	(160)	(57)	(33)	(3)	(116)	(28)	(89)	(53)	(101)	(33)

[a]N=numbers/100 stomachs; W=grams/stomach.

Table 9. Weight incidence (g/stomach), by 3-cm length-interval, for important[a] Invertebrate categories in stomachs of Pacific cod landed from Areas 5B, 5C, and 5D, September-October 1982. (Values in parentheses unusable, N<10. See Table 3).

Fork length (cm)	Area 5B Shrim	Moll	Crab	Annel	Area 5C Crab	Shrim	Shrim	Area 5D Annel	Crab
32-38	--	--	--	(0)	(0)	(0)	(40)	(0)	(0)
41	--	--	--	(0)	(0)	(4)	(T)	(0)	(0)
44	(4)	(1)	(0)	0	3	5	(12)	(41)	(1)
47	51	1	8	0	9	2	29	18	T
50	88	9	5	0	9	2	24	22	5
53	101	2	1	T	4	4	47	11	5
56	37	T	7	13	5	5	38	25	20
59	71	12	2	2	1	3	26	15	7
62	27	T	T	0	4	2	37	34	12
65	44	9	10	7	1	2	21	12	7
68	(8)	(0)	(0)	0	0	T	22	52	23
71	(7)	(0)	(0)	(53)	(0)	(0)	23	9	10
74	(110)	(0)	(0)	(0)	(0)	(0)	25	26	7
77	--	--	--	--	--	--	8	30	1
80	(5)	(0)	(0)	--	--	--	24	124	1
83-89	--	--	--	--	--	--	(0)	(10)	(0)
Unknown	--	--	--	--	--	--	(52)	(0)	(0)
Total	57	5	4	4	4	3	28	24	10

[a]Annel=Annelida; Moll=Mollusca; Shrim=Shrimp.

Table 10. Weight incidence (%), by area and category, of Miscellaneous categories in stomachs of Pacific cod landed from Areas 5A-5E, September-November 1982. (Source: Appendix Table 5)

Category	Area 5A	5B	5C	5D	5E	Total
Algae, seaweed	--	--	--	T	--	T
Stones, sand	4.8	6.4	12.7	5.4	9.5	8.7
UDM[a]	92.8	92.8	84.3	91.9	90.5	88.5
Wood	--	T	T	T	--	T
Unclassified	--	T	0.6	1.4	--	1.0
Parasites	2.4	0.8	2.4	1.4	--	1.9
Total	100.0	100.0	100.0	100.1	100.0	100.1
(g/stomach)	(83)	(125)	(166)	(74)	(42)	(104)

[a]Unidentified digested material.

Table 11. Weight incidence (g/stomach), by 3-cm length-interval of important Miscellaneous categories[a] in stomachs of Pacific cod landed from Areas 5B, 5C, and 5D, September-October 1982. (Values in parentheses unusable, N<10. See Table 3)

Fork length (cm)	Area 5B			Area 5C			Area 5D		
	UDM	Ston	Para	UDM	Ston	Para	UDM	Ston	Para
32-38	--	--	--	(0)	(0)	(0)	(58)	(5)	(0)
41	--	--	--	(25)	(9)	(0)	(22)	(0)	(0)
44	(56)	(6)	(T)	56	14	3	(4)	(40)	(2)
47	41	6	T	101	22	4	26	1	1
50	56	2	T	76	15	4	46	1	1
53	43	2	T	103	11	2	43	2	1
56	93	10	1	135	30	4	67	5	1
59	168	6	2	178	17	4	69	6	1
62	194	11	2	172	28	5	75	5	3
65	198	6	3	178	25	6	80	5	2
68	(127)	(4)	(5)	239	40	2	72	2	1
71	(336)	(143)	(0)	(197)	(13)	(3)	70	4	1
74	(83)	(0)	(0)	(312)	(24)	(3)	83	6	1
77	--	--	--	--	--	--	80	6	1
80	(120)	(0)	(0)	--	--	--	42	2	1
83-89	--	--	--	--	--	--	(255)	(7)	(T)
Unknown	--	--	--	--	--	--	(40)	(0)	(0)
Total	117	8	1	140	21	4	68	4	1

[a]Para-Parasites; Ston-Stones & Sand.
UDM-Unidentified Digested Material.

Table 12. Trawl landings (t), by month and MSA, of Pacific cod from Areas 5C and 5D, September-October 1982. (Source: Leaman 1983)

MSA[a]	Sep	Oct	Nov	Total	%	Jan-Dec	%
				Area 5C			
2BE	23.9	7.7	8.7	40.3	97.6	501.0	99.2
5L	0.8	0.2	--	1.0	2.4	4.2	0.8
6	--	--	--	--	--	--	--
Total	24.7	7.9	8.7	41.3	100.0	505.2	100.0
				Area 5D			
1E	T	1.0	2.4	3.4	1.7	23.8	1.5
2AE	--	--	--	--	--	6.7	4.3
4	102.4	8.4	20.8	131.6	64.7	1033.0	66.2
5U	2.2	2.8	63.4	68.4	33.6	496.0	31.8
Total	104.6	12.2	86.6	203.4	100.0	1559.5	100.0

[a]Minor statistical area. See Fig. 1.

Table 13. Length-frequencies (nos.), by 3-cm length-interval, ground, and/or MSA, of Pacific cod sampled for stomach contents, in commercial landings from Areas 5C and 5D. September-October 1982.

	5C					5D		
MSA:[a]	2BE		6	1E		2AE	4	
Ground:[b]	HS	UNK	UNK	MB	UNK	UNK	TP	UNK
Fork length (cm)								
32	1	--	--	--	--	--	--	--
35	0	--	--	--	--	1	--	--
38	0	--	--	--	--	0	--	--
41	4	--	--	--	--	1	1	1
44	6	10	8	--	--	2	1	1
47	2	16	5	16	2	6	1	4
50	7	11	19	15	6	9	7	10
53	10	15	13	16	6	20	19	10
56	13	18	11	19	15	19	17	16
59	28	12	17	17	20	20	21	19
62	18	10	8	7	15	18	23	25
65	20	6	12	5	12	15	29	21
68	12	2	3	0	7	18	26	26
71	2	1	1	1	4	18	26	14
74	2	--	3	2	10	15	15	7
77	--	--	--	1	1	9	8	10
80	--	--	--	--	0	2	4	4
83	--	--	--	--	1	1	2	2
86	--	--	--	--	--	--	1	0
89	--	--	--	--	--	--	--	2
Sub-total	125	101	100	99	99	174	201	172
Unknown	--	--	--	1	--	--	--	2
Total	125	101	100	100	99	174	201	174
$\bar{L}$	58.7	54.2	56.2	61.6	62.3	64.2	63.6	64.2
C.V. (%)	13	12	13	12	12	15	13	14

[a]Minor statistical area. See Fig. 1

[b]Ground: HS=Horseshoe: MB=McIntyre Bay: TP=Two Peaks; UNK=Unknown; See Fig. 2.

Table 14. Number and weight incidences (%), by ground and/or MSA, of Major Components in stomachs of Pacific cod landed from Areas 5C and 5D. September-October 1982. (Source: Appendix Tables 6-8)

MSA[a]	Grnd[b]	Incid[c]	Component Fish	Invert	Misc	Total	N[d]
			Area 5C				
2BE	HS	N	43.4	10.9	45.6	99.9	458
		W	56.3	2.9	40.8	100.0	343
5L	UNK	N	48.4	15.9	35.7	100.0	572
		W	65.4	3.3	31.3	100.0	520
6	UNK	N	56.5	9.9	33.6	100.0	767
		W	56.4	2.3	41.4	100.1	486
			Area 5D				
1E	MB	N	12.6	61.9	25.5	100.0	444
		W	15.4	53.8	30.8	100.0	143
	UNK	N	59.9	10.0	30.1	100.0	621
		W	74.4	2.8	22.8	100.0	570
2AE	UNK	N	24.7	51.3	24.0	100.0	596
		W	56.0	22.1	21.9	100.0	389
4	TP	N	21.9	43.0	35.1	100.0	402
		W	56.7	19.7	23.6	100.0	305
	UNK	N	7.3	78.4	14.2	99.9	807
		W	30.2	48.8	20.9	99.9	258

[a]Minor statistical area. See Fig. 1.

[b]Ground: HS-Horseshoe; MB-McIntyre Bay: TP-Two Peaks: UNK-Unknown: See Fig. 2.

[c]Incidence: N-numbers: W-weight.

[d]Incidence units: N-numbers/100 stomachs: W-grams/stomach.

Table 15. Weight incidence (%) of important[a] Fish categories in stomachs of Pacific cod landed from grounds and/or MSAs in Areas 5C and 5D. September-October 1982.

Area:		5C					5D		
MSA:[b]		2BE	5L	6	1E		2AE	4	
Ground:[c]		HS	UNK	UNK	MB	UNK	UNK	TP	UNK
Category	N[d]								
Pacific herring	8	21.1	13.7	24.5	18.2	10.4	13.8	6.9	26.9
Pacific sand lance	7	46.2	81.7	64.4	--	47.2	23.4	26.0	37.2
Flounder	6	15.4	2.7	6.3	--	16.7	9.6	16.8	--
Rockfish	4	3.8	--	0.1	--	--	33.9	2.3	2.6
Sculpin	3	--	0.2	--	--	0.9	--	--	--
Eelpout	2	8.0	--	0.1	--	--	--	--	3.8
Perch	2	--	--	--	--	21.0	--	--	--
Poacher	2	--	0.1	--	9.1	--	--	--	--
Smelt	2	--	--	--	13.6	--	0.9	--	--
Arrowtooth flounder	1	--	--	--	--	--	--	40.5	--
Prickleback	1	--	--	--	9.1	--	--	--	--
Wrymouth	1	--	--	--	9.1	--	--	--	--
Ratfish	1	--	--	--	9.1	--	--	--	--
Total		94.5	98.4	95.4	68.2	96.2	81.6	92.5	70.5
(Total g/stomach)		(274)	(340)	(274)	(22)	(424)	(218)	(173)	(78)

[a]No less than rank 5 in at least one sample.

[b]Minor statistical area. See Fig. 1.

[c]Ground: HS=Horseshoe: MB=McIntyre Bay: TP=Two Peaks: UNK=Unknown: See Fig. 2.

[d]N=number of occurrences in ranks 1-5.

Table 16. Weight incidence (%) of important Invertebrate categories in stomachs of Pacific cod landed from grounds and/or MBAs in Areas 5C and 5D, September-October 1982.

Area:	5C					5D		
MBA:[a]	2BE	5L	6	1E		2AE	4	
Ground:[b]	HS	UNK	UNK	MB	UNK	UNK	TP	UNK
Category								
Phylum								
Arthropoda	79.8	39.7	75.9	90.2	56.0	76.6	60.1	34.5
Annelida	10.1	46.0	23.2	5.9	25.2	7.4	24.3	60.8
Mollusca	10.1	10.9	0.9	1.8	4.4	7.9	0.2	0.2
Echinodermata	--	3.4	--	0.7	4.4	0.3	0.2	2.6
Coelenterata	--	--	--	0.7	--	0.8	0.2	--
Unidentified	--	T	--	0.8	10.1	7.0	14.8	1.8
Total	100.0	100.0	100.0	100.1	100.1	100.0	100.1	99.9
(g/stomach)	(9.9)	(17.4)	(11.2)	(76.8)	(15.9)	(86.3)	(59.6)	(125.6)
Arthropoda								
Shrimp	34.2	62.3	15.2	94.5	40.4	70.5	51.1	33.3
Crab	30.4	29.0	84.7	1.4	44.9	10.3	37.7	38.3
Amphipod	--	1.4	--	0.4	T	1.2	0.6	T
Crustacea	3.8	1.4	T	2.3	14.6	13.0	5.9	27.5
Euphausiid	31.6	5.8	--	--	--	5.0	4.7	0.9
Isopod	--	--	--	1.3	--	--	T	--
Total	100.0	99.9	99.9	99.9	99.9	100.0	100.0	100.0
(g/stomach)	(7.9)	(6.9)	(8.5)	(69.3)	(8.9)	(66.1)	(35.8)	(43.3)
Shrimp								
Pandalid	--	--	T	42.6	8.3	18.9	3.8	24.3
Crangonid	33.3	53.5	30.8	32.8	11.1	42.9	67.2	44.4
Argrid	3.7	T	7.7	T	61.1	0.4	T	1.4
Bladed	--	T	--	T	8.3	--	--	--
Unidentified	63.0	46.5	61.5	24.6	11.1	37.8	29.0	29.9
Total	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.0
(g/stomach)	(2.7)	(4.3)	(1.3)	(53.3)	(3.6)	(46.6)	(18.3)	(14.4)

[a]Minor statistical area. See Fig. 1.

[b]Ground: HS-Horseshoe: MB-McIntyre Bay: TP-Two Peaks: UNK-Unknown: See Fig. 2.

Table 17. Weight incidence (%), by ground and/or MSA, for Miscellaneous in stomachs of Pacific landed from Areas 5C and 5D, September-October 1982.

Area:	5C			5D				
MSA:[a]	2BE	5L	6	1E		2AE	4	
Ground:[b]	HS	UNK	UNK	MB	UNK	UNK	TP	UNK
Category								
Algae, seaweed	--	--	--	--	--	1.2	T	1.9
Stones, sand	15.7	8.6	13.9	2.3	10.8	3.5	4.1	3.7
UDM[c]	82.1	89.6	82.6	95.5	86.2	94.1	89.0	90.7
Wood	--	T	--	--	T	T	T	T
Unclassified	--	T	1.0	T	T	--	5.5	1.9
Parasites	2.1	1.8	2.5	2.3	3.1	1.2	1.4	1.9
Total	99.9	100.0	100.0	100.1	100.1	100.0	100.0	100.1
(g/stomach)	(140)	(163)	(201)	(44)	(130)	(85)	(73)	(54)

[a]Minor statistical area. See Fig. 1.

[b]Ground: HS-Horseshoe: MB-McIntyre Bay: TP-Two Peaks: UNK-Unknown: See Fig. 2.

[c]Unidentified Digested Material.

Table 18. Total stomach contents (g/stomach)[a], by 1-cm length-interval, as a percentage of dressed weight (g) for Pacific cod landed from Areas 5B, 5C and 5D, September-October 1982. (Values in parentheses unusable, N<10. See Table 3).

Fork length (cm)	$\overline{DW}$[b] (g)	5B $\overline{g/s}$[c]	5B %	5C $\overline{g/s}$[c]	5C %	5D $\overline{g/s}$[c]	5D %
32-38	400[d]	--	--	14	(3.5)	(14)	(3.5)
41	646	--	--	(43)	(6.7)	(16)	(2.5)
44	801	(72)	(9.0)	40	5.0	(27)	(3.3)
47	978	57	5.9	121	12.4	33	3.4
50	1180	84	7.1	97	8.2	52	4.4
53	1408	71	5.0	110	7.8	54	3.9
56	1664	111	6.7	196	11.8	99	5.9
59	1950	146	7.5	163	8.4	116	6.0
62	2267	192	8.5	178	7.9	109	4.8
65	2616	253	9.7	153	5.8	120	4.6
68	3000	(100)	(3.3)	192	6.4	123	4.1
71	3419	(376)	(11.0)	(167)	(4.9)	150	4.4
74	3877	(94)	(2.4)	408	10.5	122	3.2
77	4373	--	--	--	--	83	1.9
80	4911	(55)	(1.1)	--	--	204	4.2
83-89	6115[d]	--	--	--	--	(100)	(1.6)

[a]Fish + Invertebrates + Miscellaneous.

[b]Dressed weight = $0.008289\ FL^{3.0333}$; from Westrheim (1977).

[c]Mean g/stomach per 1-cm interval.

[d]$\overline{DW}$ at 35 cm.

[e]DW at 86 cm.

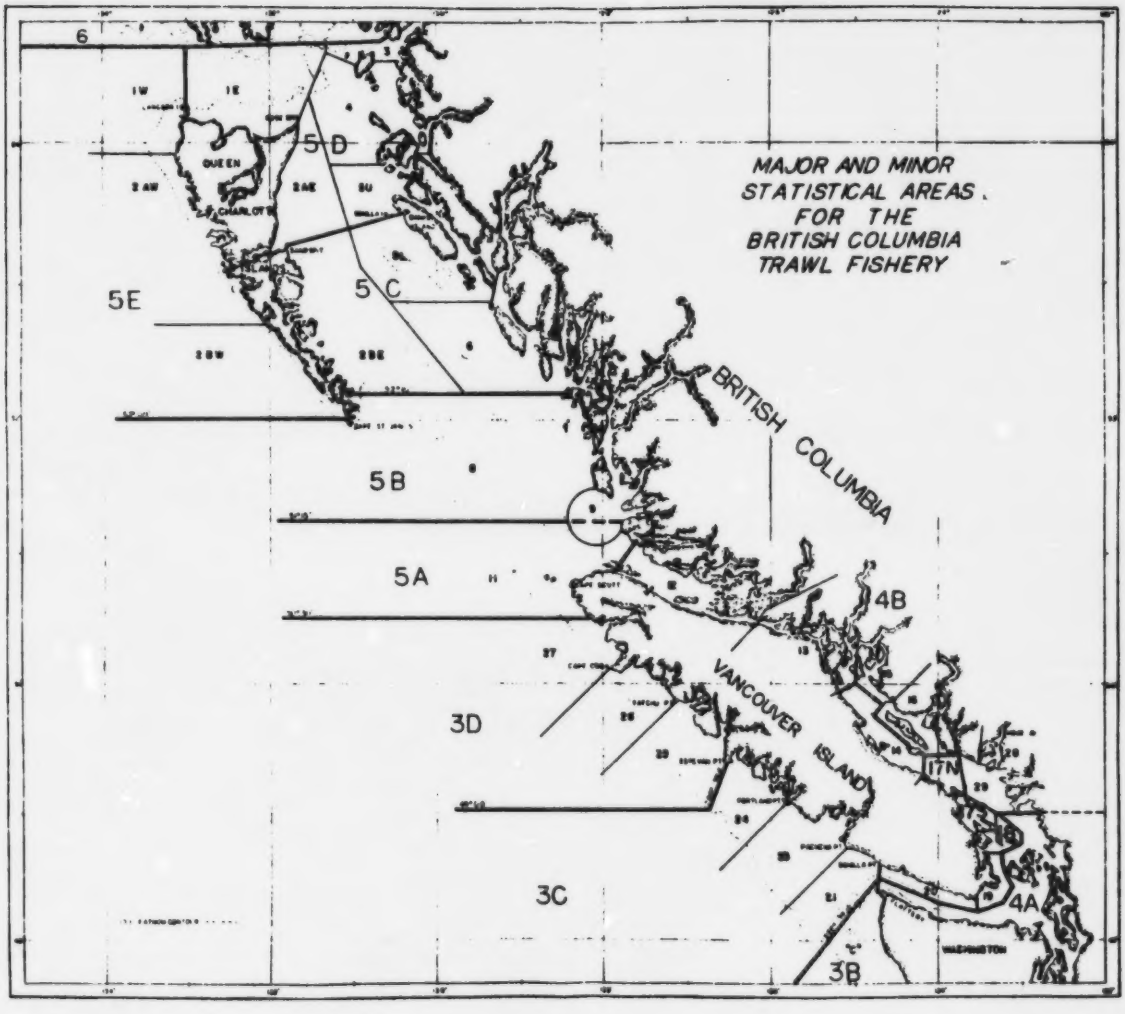


Fig. 1. Major and minor statistical areas, for groundfish, off the coast of British Columbia.

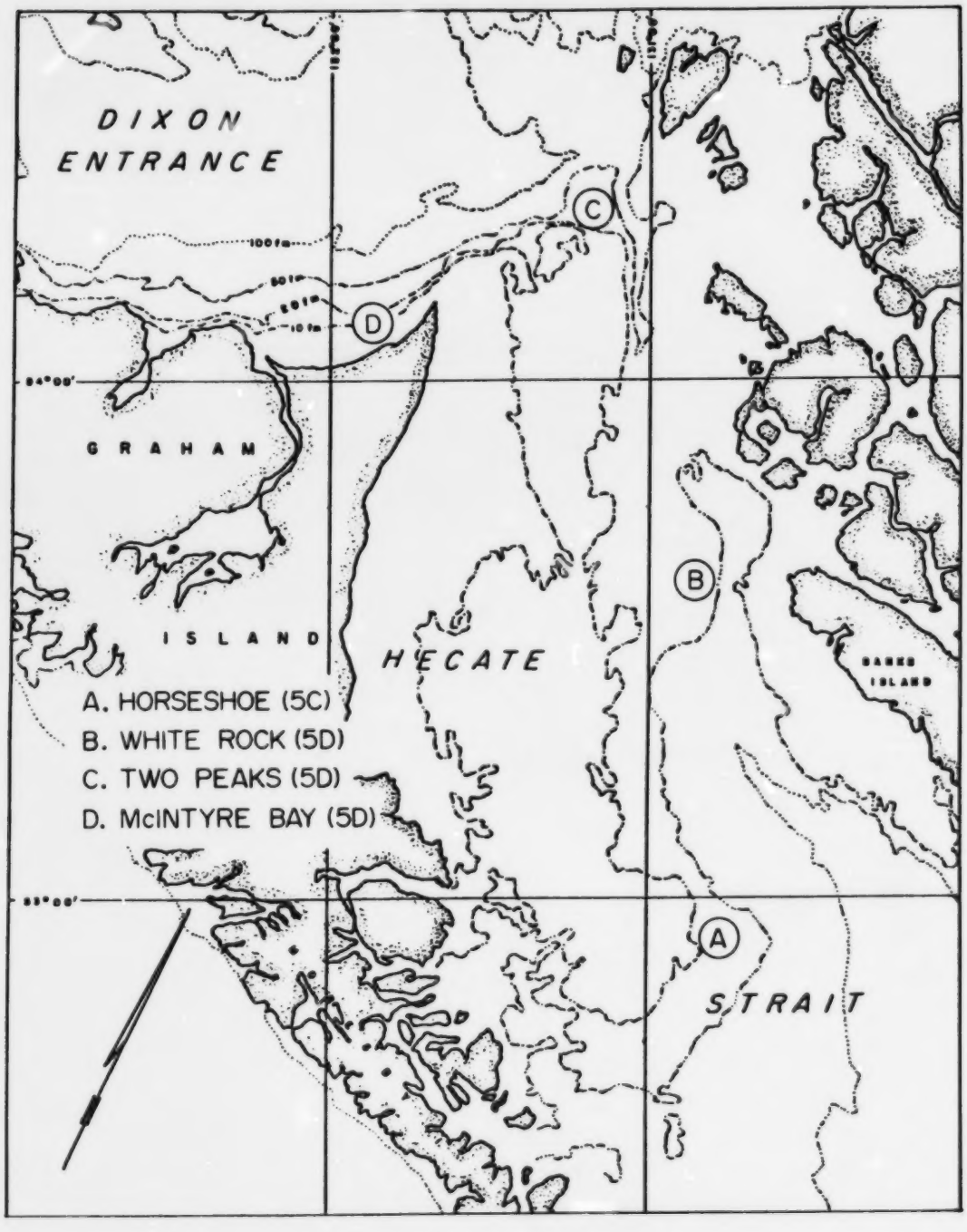


Fig. 2. Bathymetric chart of Hecate Strait and Dixon Entrance, and locations of important trawling grounds.

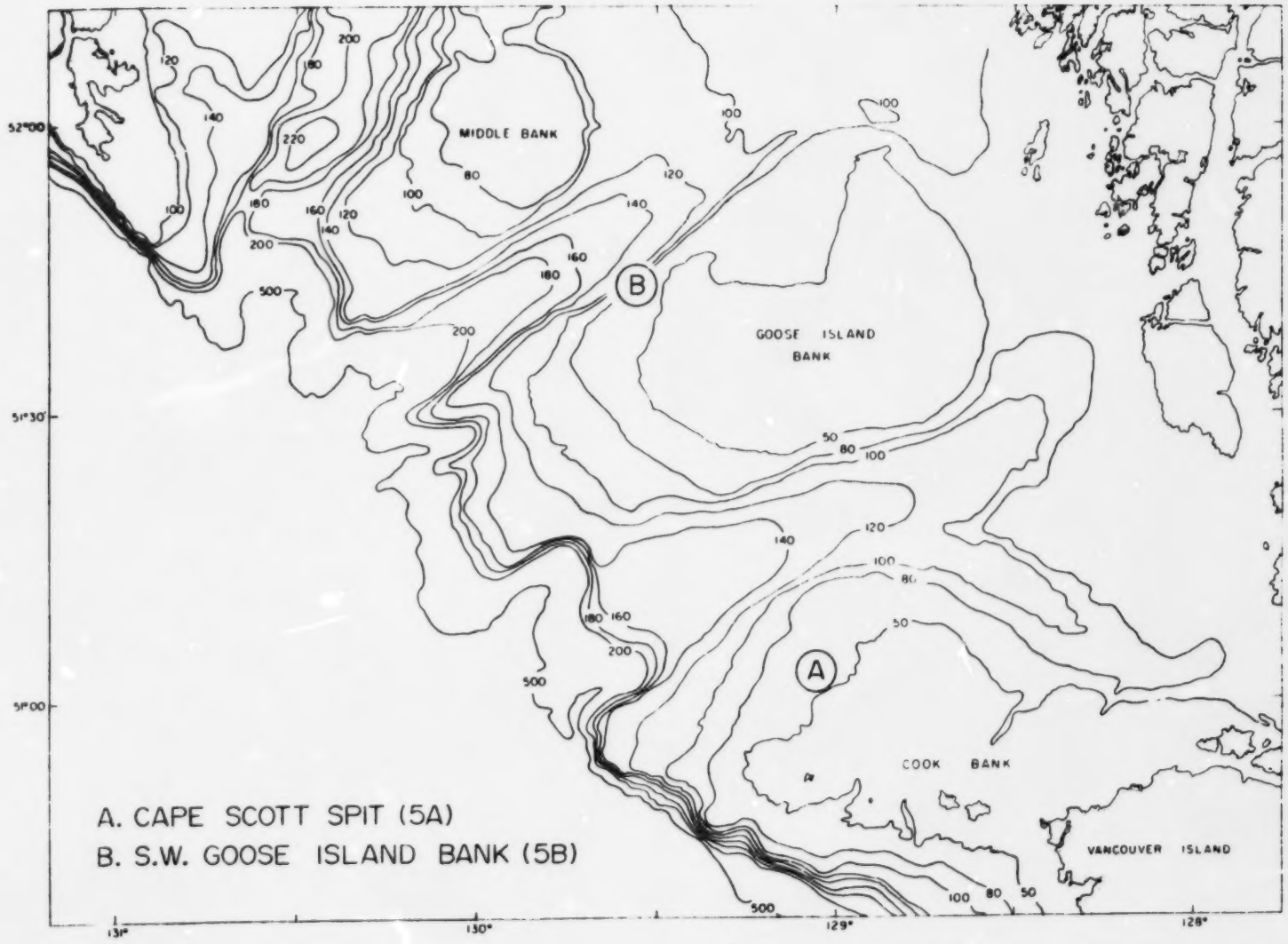


Fig. 3. Bathymetric chart of Queen Charlotte Sound, and locations of important trawling grounds.

Fig. 4. Weight incidence (g/stomach), by usable 3-cm length-interval (N>9), of Major components in stomachs of Pacific cod landed from Areas 5A-5E, September-November 1982.

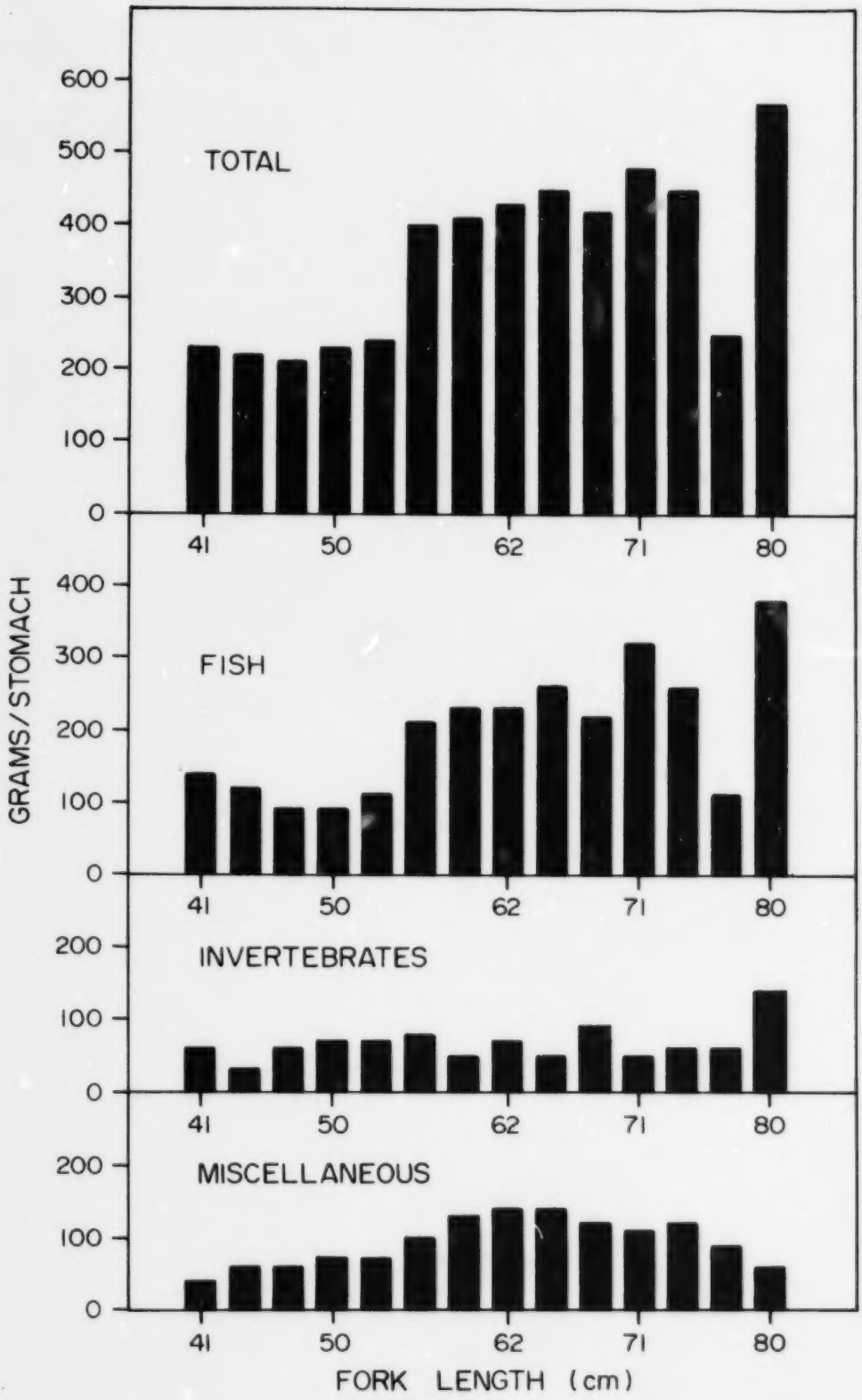
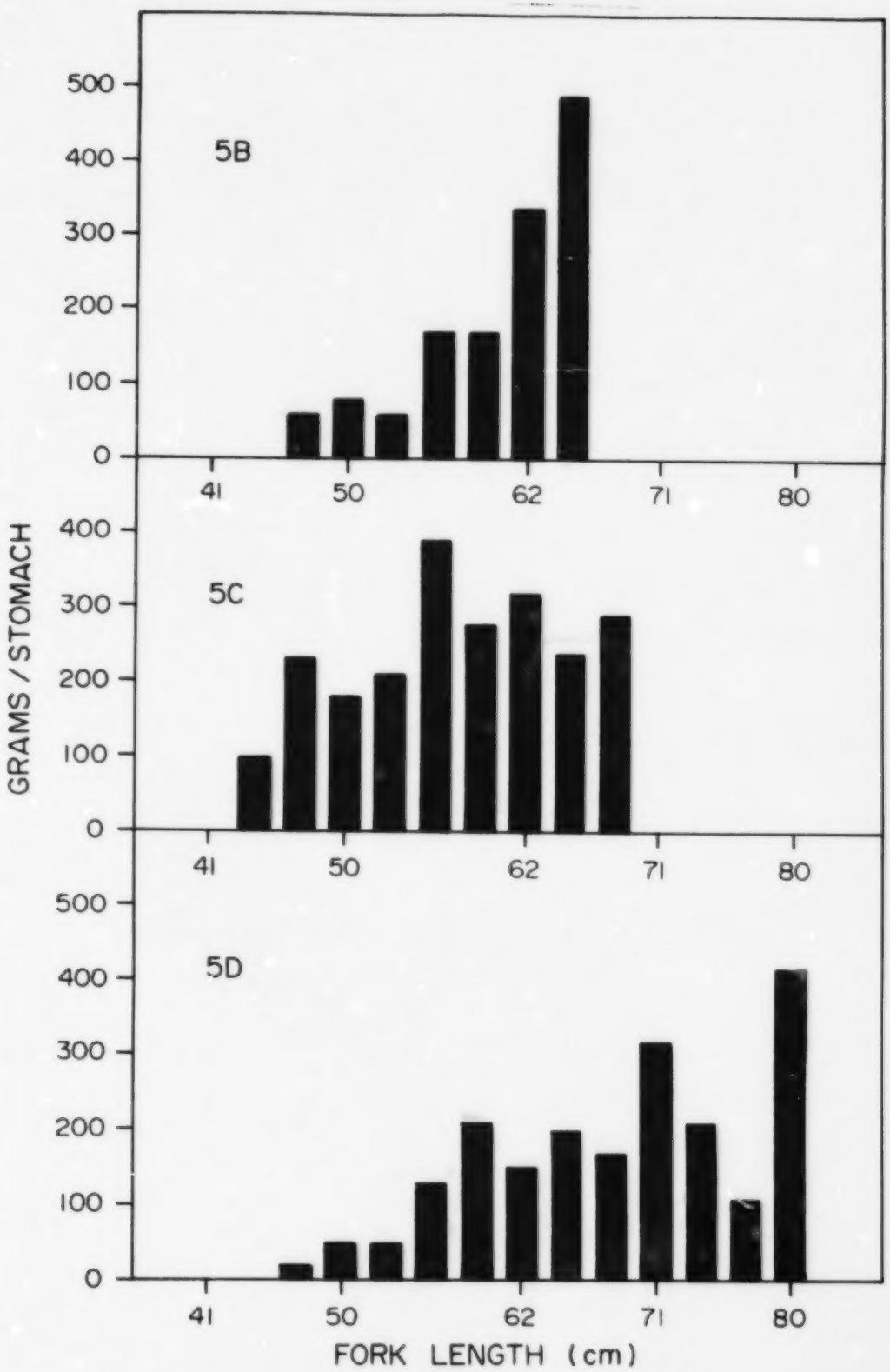

TOTAL
FISH
INVERTEBRATES
MISCELLANEOUS
GRAMS/STOMACH
FORK LENGTH (cm)
41
50
62
71
80
0
100
200
300
400
500
600

Fig. 5. Weight incidence (g/stomach), by usable 3-cm length-interval (N>9), of Fish components in stomachs of Pacific cod landed from Areas 5A-5E, September-November 1982.


5B
5C
5D
GRAMS / STOMACH
0
100
200
300
400
500
41
50
62
71
80
FORK LENGTH (cm)

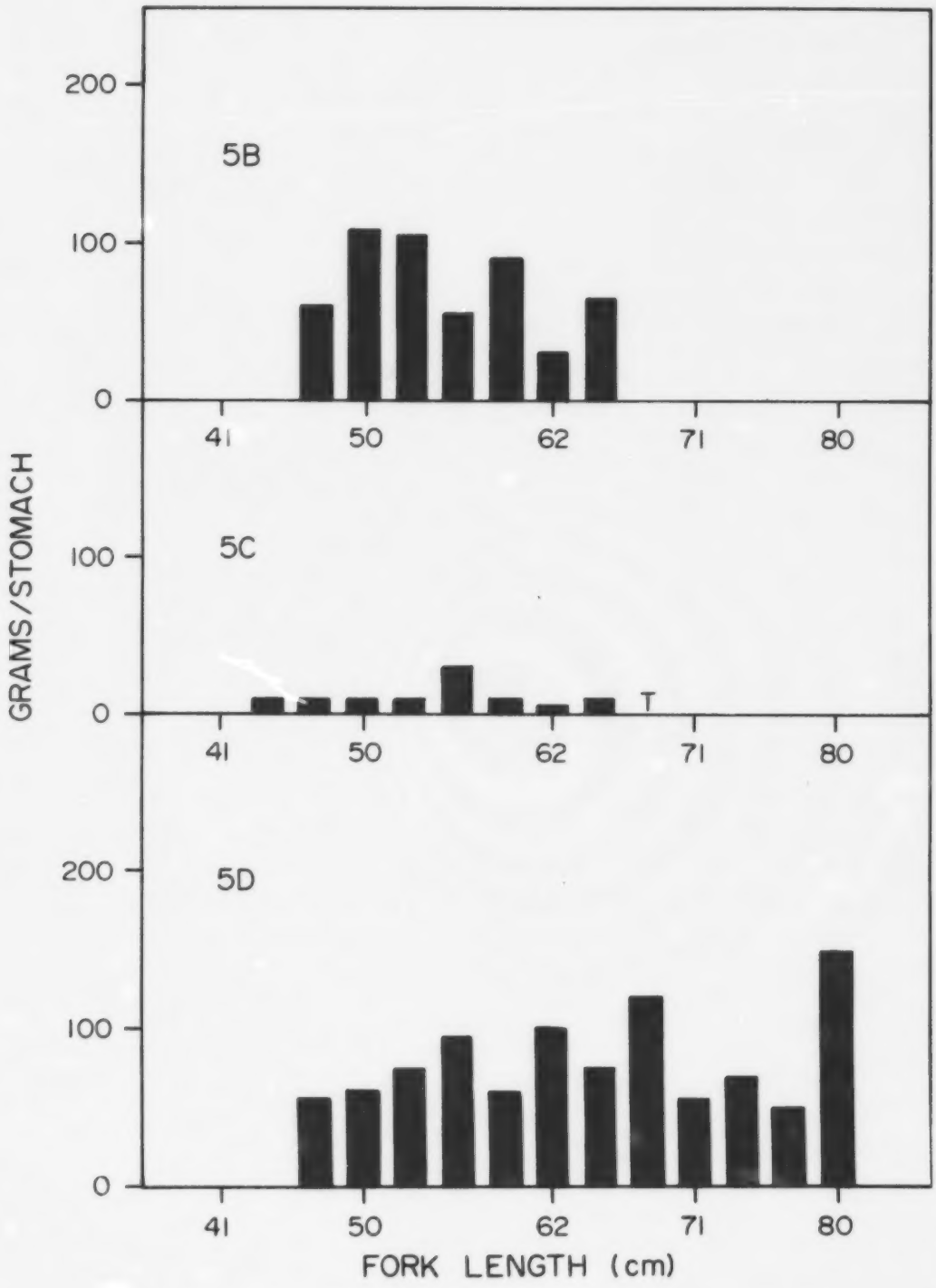


Fig. 6. Weight incidence (g/stomach), by usable 3-cm length-interval, (N>9), of Invertebrate components in stomachs of Pacific cod landed from Areas 5A-5E, September-November 1982.

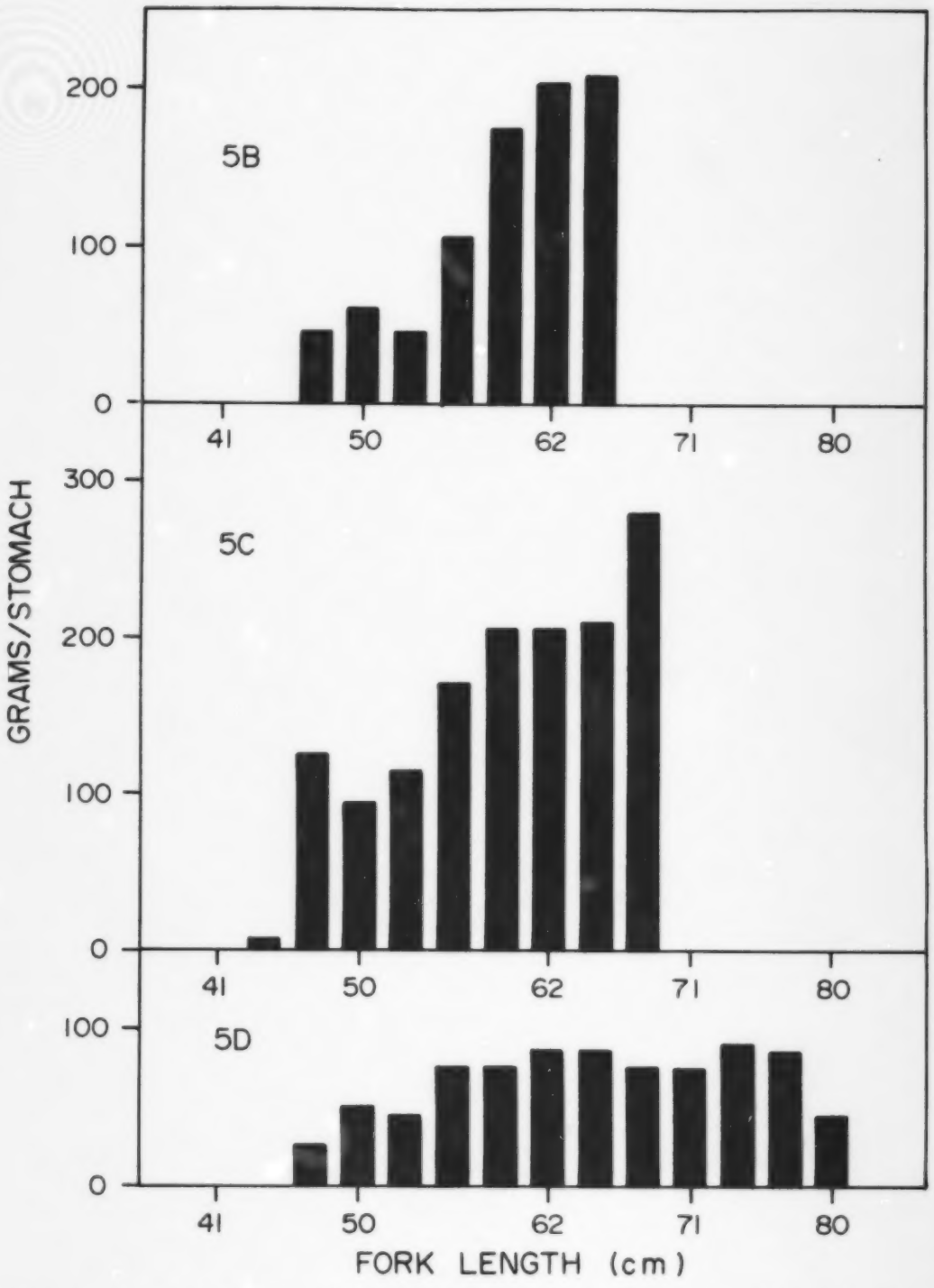


Fig. 7. Weight incidence (g/stomach), by usable 3-cm length-interval (N>9), of Miscellaneous components in stomachs of Pacific cod landed from Areas 5A-5E, September-November 1982.

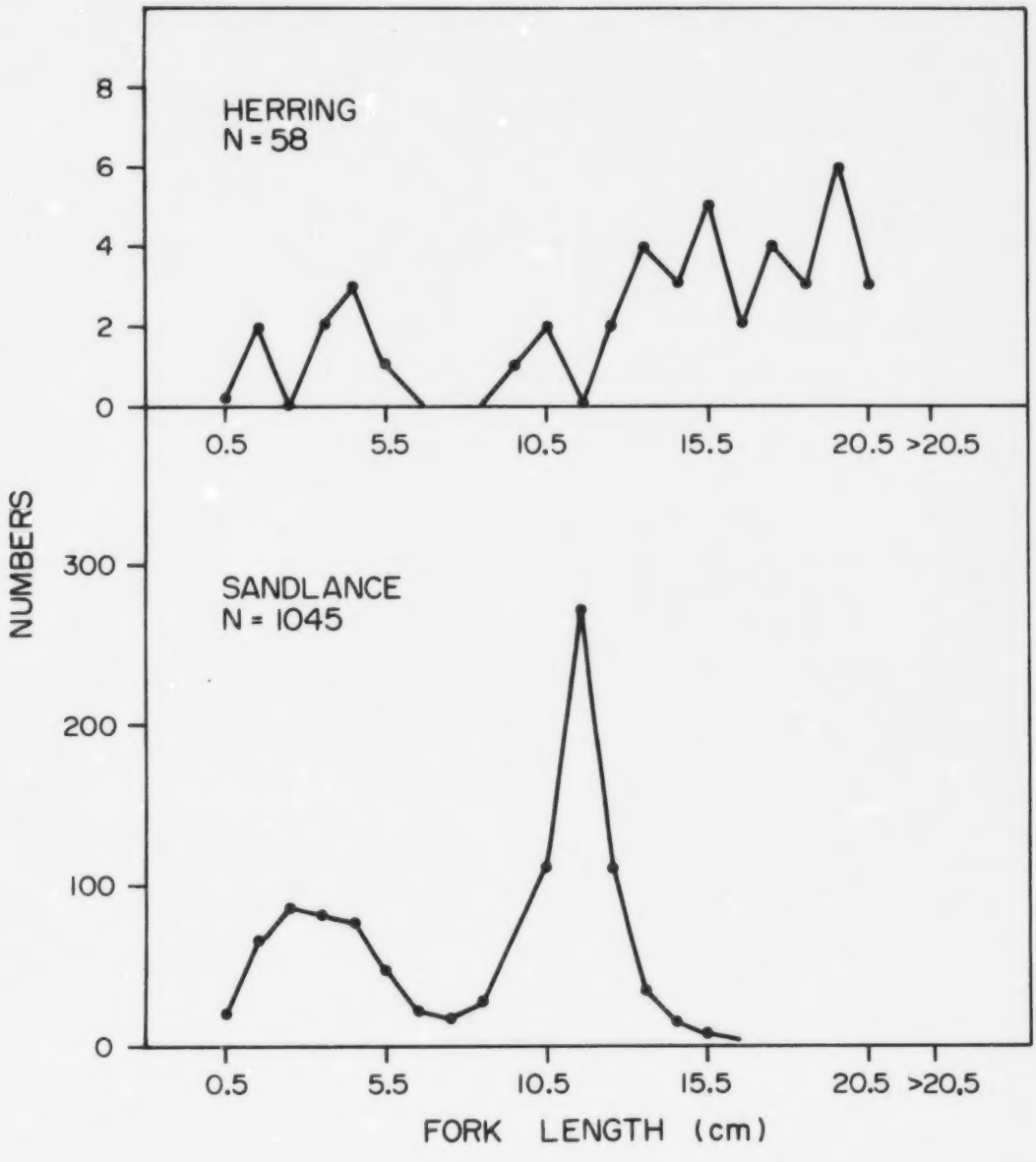


Fig. 8. Length-frequencies (nos.), by 1-cm length-interval, of Pacific herring and Pacific sand lance in stomachs of Pacific cod landed from Areas 5A-5E, September-November 1982.

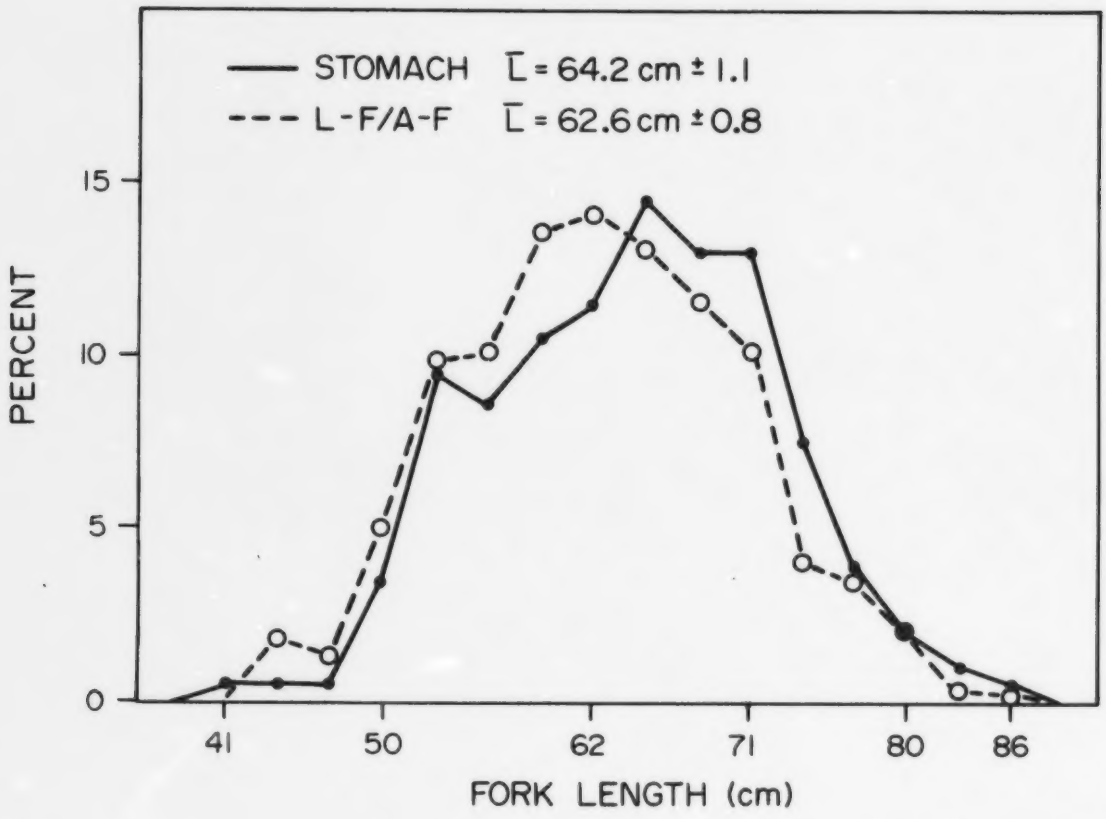
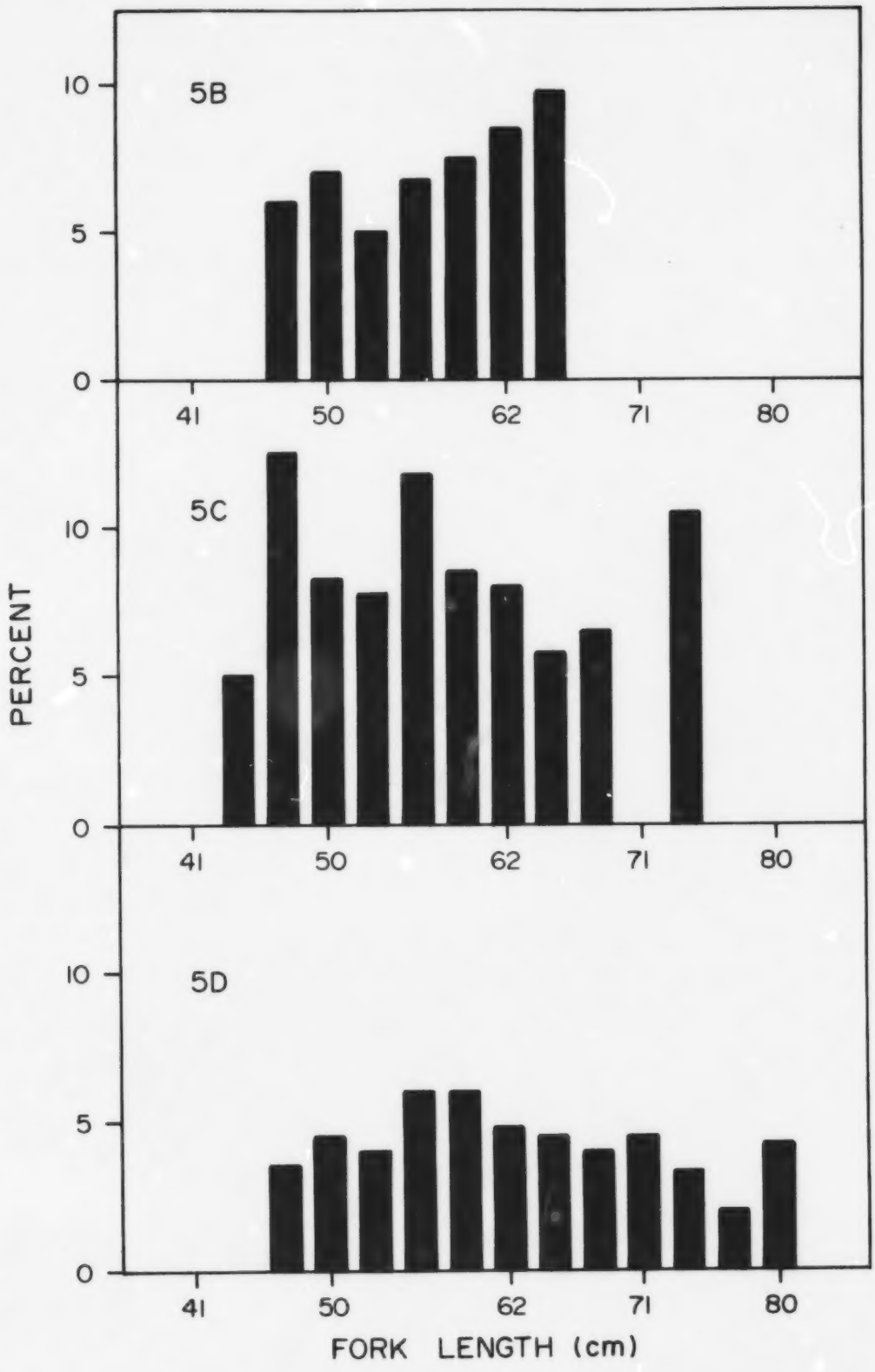


Fig. 9. Length-frequencies (%), by 3-cm length-interval and sample type, of Pacific cod landed from Two Peaks Ground (Area 5D), September-October 1982.

Fig. 10. Percent stomach-content weight of body dressed weight, by 1-cm length-interval, for Pacific cod landed from Areas 5B, 5C, and 5D, September-October 1982.


5B
5C
5D
10
5
0
41
50
62
71
80
PERCENT
FORK LENGTH (cm)

Appendix Table 1. Numbers of Fish components, by category and area, in stomachs of trawl-caught Pacific cod landed from Areas 5A-5E, September-November 1982.

Category	Total	Area 5A	5B	5C	5D	5E
Arrowtooth flounder	4	--	--	--	4	--
Dragonfish	1	--	--	--	1	--
Eelpout	35	--	33	1	1	--
Flounder	198	15	60	35	87	1
Midshipman	1	--	1	--	--	--
Pacific herring	201	21	57	56	67	--
Pacific sandlance	1540	22	155	752	511	100
Perch	40	1	--	12	27	--
Poacher	34	4	18	1	11	--
Prickleback	5	--	1	--	4	--
Rockfish	102	4	62	1	35	--
Salmonid	1	--	--	--	1	--
Sculpin	15	3	--	8	4	--
Smelt	3	1	--	--	2	--
Stickleback	1	--	1	--	--	--
Wrymouth	3	1	--	--	2	--
Ratfish	3	--	--	--	3	--
Skate	1	--	--	--	1	--
Unidentified	401	13	90	97	197	4
Total fish	2586	85	478	963	958	105
No. of stomachs	1395	102	201	326	748	18

Appendix Table 2. Weight (g) of Fish components, by category and area, in stomachs of trawl-caught Pacific cod landed from Areas 5A-5E, September-November 1982.

Category	Total	Area 5A	5B	5C	5D	5E
Arrowtooth flounder	14049	--	--	--	14049	--
Dragonfish	1	--	--	--	1	--
Eelpout	805	--	617	36	152	--
Flounder	35516	6024	6112	6392	16970	18
Midshipman	190	--	190	--	--	--
Pacific herring	65999	8734	24647	16550	16068	--
Pacific sandlance	111160	1533	2817	56732	42745	7333
Perch	10916	200	--	1941	8775	--
Poacher	1129	44	746	28	311	--
Prickleback	229	--	39	--	190	--
Rockfish	17525	386	3069	20	14050	--
Salmonid	5	--	--	--	5	--
Sculpin	1713	168	--	996	549	--
Smelt	755	175	--	--	580	--
Stickleback	15	--	15	--	--	--
Wrymouth	252	60	--	--	192	--
Ratfish	180	--	--	--	180	--
Skate	124	--	--	--	124	--
Unidentified	21203	181	2197	3095	15593	137
Total fish	281766	17505	40449	85790	130534	7488
No. of stomachs	1395	102	201	326	748	18

Appendix Table 3. Numbers of Invertebrate components, by phylum, category, and area, in stomachs of trawl-caught Pacific cod landed from Areas 5A-5E, September-November 1982.

Phylum	Category	Total	Area 5A	5B	5C	5D	5E
Coelenterata	Anemone	12	--	--	--	12	--
Echinodermata	Brittlestar	8	--	--	1	7	--
	Cucumber	12	--	--	--	12	--
	Starfish	1	--	--	--	1	--
Mollusca	Barnacle	1	--	--	--	1	--
	Octopus	2	--	1	--	1	--
	Squid	14	3	6	2	3	--
	Cephalopod	32	4	4	2	22	--
	Gastropod	81	9	27	9	35	1
Annelida	Annelid	107	9	19	8	71	--
	Echiurid	178	--	--	1	177	--
Arthropoda	Amphipod	49	9	3	6	29	2
	Crab, cancer	319	4	1	61	252	1
	hermit	14	--	--	2	12	--
	spider	12	1	--	--	11	--
	squat lobster	45	7	30	2	6	--
	Euphausiid	29	--	--	8	21	--
	Isopod	6	--	--	--	6	--
	Shrimp, argid	20	1	1	4	14	--
	bladed	5	1	--	1	3	--
	crangonid	618	30	66	51	471	--
	pandalid	397	59	188	1	149	--
	unclassified	396	26	67	53	234	16
	Crustacea	94	2	7	17	68	--
Other	Shellfish	106	--	6	1	99	--
	Unidentified	28	--	3	--	25	--
Total Invertebrates		2586	165	429	230	1742	20
No. of stomachs		1395	102	201	326	748	18

Appendix Table 4. Weight (g) of Invertebrate components, by phylum, category, and area, in stomachs of trawl-caught Pacific cod from Areas 5A-5E, September-November 1982.

Phylum	Category	Total	Area 5A	5B	5C	5D	5E
Coelenterata	Anemone	230	--	--	--	230	--
Echinodermata	Brittlestar	139	--	--	63	76	--
	Cucumber	672	--	--	--	672	--
	Starfish	39	--	--	--	39	--
Mollusca	Barnacle	5	--	--	--	5	--
	Octopus	92	--	36	--	56	--
	Squid	2469	230	816	299	1124	--
	Cephalopod	164	--	48	2	104	--
	Gastropod	300	--	43	25	183	8
Annelida	Annelid	7533	485	197	1160	5691	--
	Echiurid	12460	--	--	15	12445	--
Arthropoda	Amphipod	272	29	14	14	201	14
	Crab, cancer	7191	80	1	1161	5940	9
	hermit	993	--	--	57	936	--
	spider	286	15	--	--	271	--
	squat lobster	1201	170	866	14	151	--
	Euphausiid	1332	--	--	346	986	--
	Isopod	99	--	--	--	99	--
	Shrimp, argid	337	5	9	23	300	--
	bladed	48	16	--	3	29	--
	crangonid	11480	906	964	382	9228	--
	pandalid	22571	10030	7429	1	5111	--
	unclassified	12439	1430	3061	488	6498	959
	Crustacea	4874	13	519	54	4288	--
Other	Shellfish	2481	10	12	1	2468	--
	Unidentified	985	--	9	--	976	--
Total Invertebrates		90692	13422	14024	4108	58107	990
No. of stomachs		1395	102	201	326	748	18

Appendix Table 5. Weight (g) of Miscellaneous components, by category and area, in stomachs of Pacific cod landed from Areas 5A-5E, September-November 1982.

Category	Total	Area 5A	5B	5C	5D	5E
Algae, seaweed	412	--	40	--	372	--
Stones, sand	12097	421	1708	6923	2964	81
UDM	128425	7867	23343	45757	50766	692
Wood	45	--	13	2	30	--
Unclassified	3536	--	--	193	3343	--
Parasites	2752	225	237	1217	1073	--
Total	147267	8513	25341	54092	58548	773
No. of stomachs	1395	102	201	326	748	18

Appendix Table 6. Weight (g) of Fish components, by category and MSA/ground, in stomachs of Pacific cod landed from Areas 5C and 5D, September-October 1982.

Area:	5C			5D				
MSA:[a]	2BE	5L	6	1E		2AE	4	
Ground:[b]	HS	WBI	UNK	MB	UNK	UNK	TP	UNK
Category								
Arrowtooth flounder	--	--	--	--	--	--	14049	--
Dragonfish	--	--	--	--	--	1	--	--
Eelpout	--	--	36	--	--	--	152	--
Flounder	3724	933	1735	--	7025	3705	5751	489
Midshipman	--	--	--	--	--	--	--	--
Pacific herring	5113	4661	6776	448	4368	5255	2422	3575
Pacific sandlance	11156	27768	17808	--	19747	8807	9077	5114
Perch	1941	--	--	--	8775	--	--	--
Poacher	--	28	--	229	--	65	17	--
Prickleback	--	--	--	190	--	--	--	--
Rockfish	--	--	20	65	--	12798	804	336
Salmonid	--	--	--	--	--	5	--	--
Sculpin	925	71	--	40	419	--	90	--
Smelt	--	--	--	290	--	290	--	--
Stickleback	--	--	--	--	--	--	--	--
Wrymouth	--	--	--	192	--	--	--	--
Ratfish	--	--	--	180	--	--	--	--
Skate	--	--	--	--	--	124	--	--
Unidentified	1312	536	1247	588	1573	6845	2484	4103
Total fish	24171	33997	27622	2222	41954	37895	34846	13617
No. of stomachs	125	100	101	100	99	174	201	174

[a]MSA=minor statistical area. See Fig. 1.

[b]HS=Horseshoe; MB=McIntyre Bay; TP=Two Peaks; UNK=unknown; WBI=West Banks Island. See Fig. 2.

Appendix Table 7. Weight (g) of Invertebrate components, by phylum, category and MSA/ground, in stomachs of Pacific cod landed from Areas 5C and 5D, September-October 1982.

Area:		5C			5D				
MSA:[a]		2BE	5L	6	1E		2AE	4	
Ground:[b]		HS	WBI	UNK	MB	UNK	UNK	TP	UNK
Phylum	Category								
Coelenterata	Anemone	--	--	--	53	--	117	60	--
Echinodermata	Brittlestar	--	63	--	24	--	38	12	2
	Cucumber	--	--	--	32	70	25	--	545
	Starfish	--	--	--	--	--	--	--	39
Mollusca	Barnacle	--	--	--	--	--	--	5	--
	Octopus	--	--	--	--	56	--	--	--
	Squid	120	179	--	95	--	1029	--	--
	Cephalopod	1	1	--	31	1	52	3	17
	Gastropod	3	10	12	14	10	102	29	28
Annelida	Annelid	126	775	259	439	396	972	2839	1045
	Echiurid	--	15	--	5	--	145	70	12225
Arthropoda	Amphipod	--	14	--	26	1	140	31	3
	Crab, cancer	303	144	714	11	312	1069	1867	2681
	hermit	--	57	--	5	79	55	651	146
	spider	--	--	--	--	--	--	204	67
	squat lobster	--	3	11	75	--	76	--	--

Appendix Table 7 (cont'd)

Area:		5C			5D				
MSA:[a]		2BE	5L	6	1E		2AE	4	
Ground:[b]		HS	WBI	UNK	MB	UNK	UNK	TP	UNK
Phylum	Category								
	Euphausiid	304	42	--	--	--	501	337	68
	Isopod	--	--	--	91	--	--	8	--
	Shrimp, argid	10	4	9	3	217	32	8	40
	bladed	--	3	--	3	26	--	--	--
	crangonid	114	228	40	2149	36	3464	2459	1120
	pandalid	--	--	1	2791	34	1531	150	650
	unclassified	216	196	76	1612	38	3047	1056	745
	Crustacea	40	9	5	162	133	1487	431	2075
Other	Shellfish	--	1	--	--	148	716	1337	267
	Unknown	--	--	--	60	14	338	428	136
Total Invertebrates		1237	1744	1127	7681	1571	15016	11985	21854
No. of stomachs		125	100	101	100	99	174	201	174

[a]MSA=minor statistical area. See Fig. 1.

[b]HS=Horseshoe; MB=MacIntyre Bay; TP=Two Peaks; UNK=unknown; WBI=West Banks Island. See Fig. 2.

Appendix Table 8. Weight (g) of Miscellaneous components, by category and MSA/ground, in stomachs of Pacific cod landed from Areas 5C and 5D, September-October 1982.

Area:	5C			5D				
MSA:[a]	2BE	5L	6	1E		2AE	4	
Ground:[b]	HS	WBI	UNK	MB	UNK	UNK	TP	UNK
Component								
Algae, seaweed	--	--	--	--	--	123	36	213
Stones, sand	2740	1403	2780	142	1346	440	684	352
UDM[c]	14424	14600	16733	4162	11120	13992	12899	8593
Wood	--	2	--	--	6	13	8	3
Unclassified	--	T	193	9	T	--	690	85
Parasites (resident)	373	291	553	58	356	216	268	175
Total miscellaneous	17537	16296	20259	4371	12828	14784	14585	9421
No. of stomachs	125	100	101	100	99	174	201	174

[a]MSA=minor statistical area. See Fig. 1.

[b]HS=Horseshoe; MB=McIntyre Bay; TP=Two Peaks; UNK=unknown; WBI=West Banks Island. See Fig. 2.

[c]UDM=unidentified digested material.

Appendix Table 9. Common and scientific names of fishes mentioned in this report.

Common Name	Scientific Name
Arrowtooth flounder	*Atheresthes stomias*
Chinook salmon	*Oncorhynchus tshawytscha*
Coho salmon	*O. kisutch*
Dragonfish	Melanostomiatidae
Eelpout	Zoarcidae
Flatfish	Bothidae/Pleuronectidae[a]
Flounder	Bothidae/Pleuronectidae[a]
Lingcod	*Ophiodon elongatus*
Midshipman	*Porichthys notatus*
Pacific cod	*Gadus macrocephalus*
Pacific hake	*Merluccius productus*
Pacific herring	*Clupea harengus pallasi*
Pacific ocean perch	*Sebastes alutus*
Pacific sandlance	*Ammodytes hexapterus*
Perch	Embiotocidae
Petrale sole	*Eopsetta jordani*
Poacher	Agonidae
Prickleback	Stichaeidae
Ratfish	*Hydrolagus colliei*
Rock sole	*Lepidopsetta bilineata*
Rockfish	Scorpaenidae
Sablefish	*Anoplopoma fimbria*
Salmonid	Salmonidae
Sculpin	Cottidae
Shiner perch	*Cymatogaster aggregatus*
Skate	Rajidae
Smelt	Osmeridae
Spiny dogfish	*Squalus acanthias*
Stickleback	*Gasterosteus aculeatus*
Walleye pollock	*Theragra chalcogramma*
Wrymouth	Cryptacanthodidae

[a]May contain some specimens of *Atheresthes stomias*.

Appendix Table 10. Common and scientific names of invertebrates mentioned in this report.

Common Name	Scientific Name
Crab, cancer	*Cancer* sp.
Crab, hermit	*Pagurus* sp.
Crab, squat lobster	*Munida* sp.
Echiurid	*Echiurus echiurus*
Shrimp, argid	*Argis* sp.
Shrimp, bladed	*Spirontocaris* sp.
Shrimp, crangonid	*Crangon* sp.
Shrimp, pandalid	*Pandalus* sp.